PUBLISHED EVERY SATURDAY BY
THE W. J. JOHNSTON COMPANY, Limited,
167-177 TIMES BUILDING, NEW YORK.
Established 1874. Incorporated 1889.
Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, Room 28, Hathaway Building, 620 Atlantic Ave., Boston.
Western Office, 465 The Rookery, Chicago.
Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION, IN ADVANCE, ONE YEAR, $3.

(Including Postage in the U. S., Canada or Mexico.)
IN CLUBS of four or more, $2.50 a year each; with a free extra copy to the getter up of a club of 8. Foreign subscription, $6 a year.

In requesting your address changed, give **old** *as well as new address.*

ESTABLISHED 17 YEARS AGO, THE ELECTRICAL WORLD is the Pioneer Electrical Journal of America and has well maintained its lead. It has the LARGEST CIRCULATION of any electrical periodical in the world, and is the BEST ADVERTISING MEDIUM.

Advertising Rates are much lower than those of any other similar publication, circulation and standing considered, and vary according to space, position and number of insertions. Quotations promptly furnished.
Situation or Help Wanted advertisements $1 to $2 an insertion, according to length.

Address all communications to
THE W. J. JOHNSTON COMPANY, Ltd.
Times Building, New York,
OR ANY OF THE BRANCH OFFICES.

VOL. XVII. NEW YORK, MARCH 28, 1891. No. 13.

CONTENTS

EDITORIAL: PAGE.
Paragraphs ... 237

ILLUSTRATED ARTICLES:
The Electric Light in Old Athens ... 239
Municipal Plant at Webster City, Ia ... 240
Inductive Disturbances in Telephone Circuits, by J. J. Carty ... 241
The Construction and Care of Electric Railroads: III. Erection of the Feed and Trolley Wires, by Arthur E. Colgate ... 243
The Magnetic Circuit of Transformers: Closed versus Open, by S. Eversheds ... 243
Transformer Distribution, by J. Swinburne ... 245
The Cambridge Accumulator ... 246
The Newton Lamp Extension Device ... 246
Wirt Pressure Indicator ... 246

MISCELLANEOUS:
Latest Foreign Electrical News ... 238
New Book ... 238
Prospect of Reduced Telephone Charges ... 238
The Pittsburgh Electric Club ... 238
Table of Large Compounded Wires, by Carl Hering ... 238
Statistics of Electric Lighting in Massachusetts ... 240
Electric Tramway at Rome ... 240
Transformer Formulæ ... 242
New Classification of the Electrical Section of the World's Fair ... 246
An Electrical Arcadia, by E. H. Johnson ... 247

FINANCIAL INTELLIGENCE: The Electrical Stock Market, 248; New Incorporations, 249; Affairs of the Companies, 249.

SPECIAL CORRESPONDENCE: New York Notes, 249; New England Notes, 249; Philadelphia Notes, 249; Western Notes, 250; Southern Notes, 250.

ANSWERS TO CORRESPONDENTS ... 250

NEWS OF THE WEEK: The Telegraph, 250; The Telephone, 250; The Electric Light, 250; The Electric Railway, 251; Personals, 251; Legal Notes, 251.

INDUSTRIAL AND TRADE NOTES ... 251

BUSINESS NOTICE ... 251

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 252

An Interesting Central Station.

ON another page will be found a full description of a typical continental electric light station of the best class. It is not only instructive from the engineering standpoint, but interesting as showing the introduction of modern improvements into the seat of the most magnificent of ancient civilizations. Athens would not seem at first thought a promising field for modern improvements, but the new Greece does not constitute by any means the rear guard of the march of progress. Even a glance will show that the Athenians of to-day have given the electric light a warm welcome. After a year and a half of operation they have installed nearly 4,000 incandescent lamps, beside a large number of arc lamps and motors. In fact, the competition has forced the gas companies to put in fittings free of charge. The demand is constantly increasing, and electricity has in these latter days found a firm foothold in the greatest city of the nation that gave name to that potent agent of progress.

Modern Electrical Theories.

ONE of the questions that confront those interested in electrical education is a formidable one. How far is it possible or practicable to give to a student beginning the study of electricity an adequate idea of the modern concepts of the subject? Five years has made a tremendous change in theoretical electricity; a change as great even as the developments of the more practical side of the science. It has not been so much a radical change that disturbs the old theories and impugns their correctness as a shifting of the point of view; it is a part really of that splendid tendency toward generalization that is gradually binding together all physical phenomena. A few years ago electricity and its twin brother, magnetism, were looked upon as quite apart from other branches of science, as widely separated from most of them, and connected with the others by comparatively feeble links. To-day electromagnetic theory is almost a part of general dynamical theory; the last steps have not been taken, the chain of evidence is not quite completed, but the general result can be clearly foreseen. This fact makes the study of electricity in some sense simpler, yet, on the whole, more abstruse, from its far-reaching relations. In this period of change, then, it becomes difficult to decide how far we are to boldly seize the new and how far cling to the old. The text-books are behind the age, and the facts must be sought in the current periodicals. To the student we can give no better advice than to study the former carefully, as a general groundwork for his knowledge, and spend all the time he can get in following up the results of contemporaneous investigation. Electrical books just at this time are out of date almost before they are off the press, whether they deal with theory or with practice. The periodical literature is our only means of keeping up with the times and following the marvelous advances that are being made.

Electric Lighting in Tunnels.

SINCE the recent unfortunate accident in the Fourth Avenue tunnel, a great deal of attention has been attracted to the subject of properly lighting such underground structures. Of course, it is well understood that the railroad authorities involved in the accident will object vociferously to every precaution that will entail upon them any considerable expense. It would be far more to their taste to frighten the public into allowing that needless abomination, an open tunnel. Nevertheless, leading engineers assert, as the result of long experience, that tunnels can be properly lighted and ventilated if sufficient care is exercised. The Hoosac tunnel, the longest in the country, is excellently ventilated, and brilliantly lighted by incandescent lamps. The results there show that accidents from inability to see signals would be quite impossible. We recently had the pleasure of seeing specifications for the proposed lighting of one tunnel near New York that certainly are a model which the New York Central and New Haven authorities would do well to follow. Incandescent lamps were to be placed every 25 feet along either side of the tunnel; so that two 16 c. p. lamps would illuminate every 25 feet of tunnel. Under such circumstances the lighting of car lamps would become unnecessary; thus another source of danger would be eliminated. At the present time the cost of incandescent lighting is so moderate that employing such a system in all tunnels would not cause a serious drain on the resources of the wealthy corporations involved. It is high time that some steps were taken to provide for the proper ventilation and illumination of all railway tunnels as a measure of safety to the passengers. Experience has shown that the objections raised to steam heating of cars, electric lighting of yards and tunnels, and, at least, gas lighting in the cars are emanations from the pocketbook and not based on any sound reasoning. Such being the case the safety of the traveling public ought, so far as it depends on these improvements, to be secured by legislative enactments.

Everyday Uses of Electricity.

WE print elsewhere a very interesting communication from the pen of Mr. Edward H. Johnson in the columns of that enterprising young daily the New York *Recorder*, of last Sunday. It is well worth while for every one interested in the development and improvement of cities to read it carefully. Somewhat Utopian though it may seem at first sight to be, very many of the suggestions made in it are not only possible but practicable. It may be many a year before we have electric cabs trundling about the streets, and electric victorias rumbling through the park, but a vast deal can be done even now with electricity toward making the metropolis of this great nation a much more comfortable and agreeable place to live in than it is at present. Electrical heating is perhaps a somewhat violent remedy for the smoke nuisance, and rather costly at present. But even if this should not prove practicable, the universal use of electric motors would reduce the black cloud that hovers over every large city to dimensions at least tolerable. First of all let us have a proper system of electrical subways; thus armed, the other problems can be attacked with a reasonable prospect of success. When every street in New York contains mains from which can be furnished electric power and light at a reasonable price, the thousands of small steam engines that handle the varied industries of the city can be displaced. Then electrical rapid transit must come, and once the distribution difficulty is settled this latter task may be found immensely easier. This last decade of the century is pre-eminently the dawn of the century of electricity, and nothing can better attract attention to the coming dependence of our civilization on electricity than such a clever and enthusiastic discussion of its possibilities. We may not be ready for it all now, but it is at least worth thinking about, not as we think of seven-league boots and flying machines, but as our grandfathers thought of the possibilities of that interesting innovation the steam railroad and the probability that it might materially extend the facilities for commercial intercourse.

Telephone Charges.

A BRIEF communication from one thoroughly conversant with the cost of telephonic apparatus calls our attention to the high rates charged for telephone service in this country. We look with pride on the extent to which that most marvelous instrument has come into use in facilitating all kinds of communication, we admire the energy and enthusiasm with which the whole system has been brought to its present state of perfection, but we cannot help regretting some of the results of the existing monopoly. No one grudges the successful inventor due reward for the fruits of his genius, but the public that, through its administrative officers, grants patent rights certainly has some claim for consideration. Patents do not necessarily involve the establishment of monopolies, but they can very readily be made to do so, and in the case of the telephone such has been the result. Telephone charges in this country are nearly double what has been found across the line in Canada to be a paying basis for the service, and one cannot avoid feeling that it is about time telephony came down to the business maxim of "large sales and small profits." It is, indeed, an open question whether a reduction in price would not so enhance the number of subscribers as to make the net results to the telephone companies quite as great as at present. Such a course would certainly meet with general approval, and would secure the companies adopting it a place in public opinion that they do not now hold. In a very few years the telephone patents will have expired, and the corporations that extend and cheapen their service now will, when that day of reckoning with competition arrives, be far more likely to retain the practical monopoly of a great industry than if they delay the reduction of their charges until the time when competing organizations force them so to do.

Telephonic Induction.

AT the last meeting of the American Institute of Electrical Engineers much interest was excited by Mr. J. J. Carty's paper on "Inductive Disturbances in Telephone Circuits," given in full elsewhere in our columns. The phenomena of induction, especially the exasperating variety known as cross-talk, has been only too familiar on telephone circuits ever since the telephone came into general use. They have been very naturally ascribed to electromagnetic action between neighboring circuits and the one on which the unfortunate subscriber is located. Mr. Carty has done a good work in pointing out and demonstrating, by a series of very neatly arranged experiments, that in the case of mutual action between two telephone lines resulting in cross-talk or other disturbances, the trouble is in every case not due to electromagnetic action, but static induction. Of course, whenever a telephone line is charged or the charge varied by the varying currents employed in the transmitter, there must necessarily follow both electromagnetic induction and the same electrostatic effect that is observed when one charges either plate of a condenser. The two exist together, but are quite distinct from each other, and their several effects can be differentiated in a variety of ways. For example, the electrostatic induction can be cut off by a metallic screen, which is, however, incapable of affecting the electromagnetic induction to any considerable extent. Then again in a wire subject to electromagnetic action the disturbance will be nearly uniform along the entire line, while if there be an electrostatic charge there may exist, and usually will exist, neutral points where the electrostatic forces are balanced. This latter line of experimentation was the one followed by Mr. Carty. His work shows, beyond a doubt, that in the case where two telephone lines run parallel to each other for any considerable distance, the electrostatic induction is very marked, producing serious disturbances in the instruments, or giving rise under proper conditions to cross-talk of the most characteristic kind. Under the same conditions no evidence of pure electromagnetic action could be obtained. These facts can be amply substantiated from theoretical reasoning. The impedence and resistance of the average telephone line is high, and, if the coefficient of mutual induction between any two parallel wires be computed, it will be found that under the conditions of telephone service above mentioned, and with the small currents employed, the electromagnetic effect will be inappreciable, the telephone being used as the detecting instrument, With electrostatic induction quite the reverse is true. Again, if one computes the electromagnetic disturbance effect of an alternating current, such as is used for incandescent lighting, on a telephone line, it will be found that, though the induced currents rise to a magnitude sufficient to cause trouble, they are by no means as large as one might at first sight be led to suspect. Therefore in actual telephone service both kinds of induction must be guarded against in order to secure immunity from the most annoying difficulties. Of the two, it is, as a matter of fact, rather harder to get rid of the electrostatic induction. One curious result of Mr. Carty's researches is that a double metallic circuit may possibly be rendered unnecessary if proper precautions are taken to avoid pure electromagnetic induction. The paper is full of suggestive points for telephonists, and represents a very large amount of careful, practical investigation. The theoretical basis of the results is sound, and the experiments are cleverly devised to bring out the exact facts in the case.

Latest Foreign Electrical News.

(By Cable from our Regular Correspondent.)

London, March 23, 1891.—The first words over the London-Paris telephone line were spoken on last Tuesday by M. Amoit, of the French Telegraph Department. On Wednesday congratulatory messages were exchanged between the Postmaster-General and M. Roche, the Minister of Commerce. Afterward the press exchanged greetings. The speech proved to be excellent.

During the recent heavy snows, the land telegraph lines being interrupted, cable dispatches received at the Eastern Company's stations were redispatched to London via Malta and Marseilles, a distance of 9,000 miles. Sixteen hundred messages were thus sent in 24 hours.

The bill for the extension of the City & South London Railway to Islington was rejected on Tuesday last.

The St. Pancras Vestry Electrical Exhibition was opened on Monday by the Lord Mayor of London.

Steps have been taken toward the formation of a London association for securing lower telephone rates and metallic circuits in place of the present service.

It is proposed that a permanent electrical museum should be formed under the auspices of the Institution of Electrical Engineers, for the purpose of collecting and preserving in one building electrical objects of historic value, which are now dispersed all over the country. This proposal has met with general support in the technical press, and a committee of the Institution will shortly be appointed to take further steps to forward this admirable suggestion.

NEW BOOK.

Die Elektrischen Verbrauchsmesser. By M. Etienne de Fodor. 218 pp., 77 illustrations. A. Hartleben, Vienna.

The neat little volume before us is the forty-third of the Electrotechnical Library, and is a brief and tolerably comprehensive account of all, or nearly all, the meters for electrical energy that have been put into practical operation. The author, M. de Fodor, is a well-known Continental engineer, just now director of the great central station in Athens, Greece, described on another page. After a brief discussion of the fundamental principles involved in the various methods of metering, and a short account of electrical units, the practical meter is taken up. According to the author's classification meters may be grouped under no less than 14 distinct headings. Of course most of these classes have few members, and are not well known in practice. Those usually employed are of three general types, the electrolytic meter, with or without self-registering mechanism; the electro-mechanical meter, dependent on various reactions of armatures, solenoids, pendulums, and the like, usually with clockwork registration; and, third, the motor meters, perhaps the largest and most interesting class of all. Naturally a large part of the book is take up with descriptions of practical apparatus falling in a general way under these three heads. The details are well given, and the book is very satisfactorily illustrated with diagramatic cuts showing the operation of the various machines. The Edison meter comes in for an elaborate discussion at the very outset, as the author has had an especially large experience with this type. But the other important forms are given with considerable fulness, and throughout the explanations are sufficiently explicit for a clear understanding of the methods of work employed. Altogether this is a very meritorious account of the various practical meters that are in use to-day, and while it does not pretend to be exhaustive, or go into analytical details to any considerable extent, it is a very desirable addition to the rather meagre literature on a most pertinent topic.

Prospect of Reduced Telephone Charges.

BY JAMES H. HOWARD.

It has been asserted time and again by the telephone monopolists during the past few years that it was impossible to reduce the telephone rates in the larger cities, because of the fact that the expense of operating the system after it reached a certain size increased so much that rates which were profitable with 500 subscribers would not pay with 1,000 subscribers, and this ratio was supposed to apply to all systems of any size. No better evidence of the falsity of this proposition can be produced than the actual state of things in Montreal, where the rates to-day are lower than in any other large city of America. The Bell patent is inoperative in Canada, owing to adverse judicial decisions. The rates charged by the Bell Telephone Company are $25 per year for both business and residential houses. The rates charged by the Federal Telephone Company, the opposition company which brought rates to their present basis, are $25 per year for private houses and $35 per year for business houses. Both companies have added largely to their subscribers since the reduction, the Bell company having about 5,000 subscribers in the city alone and the Federal company about 6,500 subscribers.

Both companies use the same system and instruments, the "Bell and Blake" telephone and transmitter; but the Federal company also gives metallic circuits, and each subscriber has his independent lines. Both companies must find the business remunerative, else they would discontinue it or raise the rates. Another instance is Berlin, with over 15,000 subscribers, charging only $50, and another is London, where, since December last, rates have dropped from £15 to £10, or $4 per month.

This proves conclusively that the business can be done, for it is being done, at rates less than one-half those prevailing in this country, and it forecasts what may be expected in the United States after the "Bell" and "Blake" patents expire in 1893, for doubtless legislatures will compel a reduction to rates fairly proportional with those existing elsewhere, and with an open field and competition the fittest will survive.

Table of Large, Compounded Wires.

BY CARL HERING.

In wiring for incandescent lamps or motors it is sometimes necessary to use wires larger than No. 00 B. & S. gauge. It then becomes necessary to compound the wire, that is, to use several smaller ones together, not only because No. 00 is the largest size which it is practicable to lay (unless the wire is stranded), but chiefly because the size wanted does not generally happen to correspond with those of the gauge numbers; and as the length of the wires is often great, a small excess over the required cross section may signify a considerable increase in the cost. In such cases it is, therefore, often desirable to obtain the closest possible approximation to the required cross section by the best combination of the sizes in the market. Those who have had to calculate such compounded wires will know what an unsatisfactory calculation it is, especially for very large cross sections, because there is no direct way of getting at the best combination; it can be done only by trial, and it is a matter of chance whether one happens to strike the right one. The number of possible combinations is naturally quite large.

It is to avoid the necessity of making these trial calculations, and to give at once the best possible approximation, that the writer has calculated the accompanying table. This table gives every possible combination of the largest four wires which it is practicable to use, namely, Nos. 2, 1, 0 and 00 B. &. S. gauge. The combined cross section of each of these combinations was calculated, and the combinations classified in the order of their combined sections. Having given the desired cross section of a compounded wire, for instance, 400,000 circular mils, one has merely to look for this size in the second column to find at once all the possible combinations which approximate this most closely; in this case it will be seen from the table that three No. 0 wires and one No. 1 will give it very closely; and there is no other combination which will give it more closely. Furthermore, as the number of combinations is comparatively great, the values often do not differ very much from each other, thus allowing some choice, which is often desirable. For instance, in this case it will be seen that three No. 00 wires will give practically the same close approximation, and this would require the handling of only one size of wire, which is sometimes greatly to be preferred. Again, the combination just above this one, namely, four No. 1 wires and one No. 2, is also quite close to the desired value; this combination would be preferable if there are many corners and bends, as the wires are smaller. It will be seen, therefore, that the table not only saves time in giving the best combination directly, but it also shows, what is often of no small importance, whether there is not another combination approximating this which has other advantages and may therefore be preferable.

Still closer approximations may in some cases be obtained, when necessary, by substituting a No. 3 or No. 4 wire for a No. 2. Moreover, this is the only way in which a closer approximation can be made. No. 2 was chosen as the smallest wire in these combinations, as it is not likely that any smaller size would be used in making up such large cross sections. Furthermore, to introduce No. 3 in this table (which gives all the possible cases) would have made it five or six times as large.

The largest limit of the cross sections in this table was taken as 500,000 circular mils, or a little less than four 00 wires. For larger sections, as, for instance, 600,000, select from the table any convenient combination, regardless of cross section, as for instance that of three 00 wires, and subtract its combined section, namely about 400,000, from the 600,000, and then find from the table the best combination to make up this balance of 200,000, as, for instance, one No. 00 and one No. 2 wire.

Circular mils were chosen as units in place of square mils, because they are a much more rational unit with which to calculate wires, and also because the square mils are going out of use very rapidly for such calculations, which is as it should be. To those not familiar with the term circular mil, it may be said here that it is the area of a circle one mil in diameter. The square of the diameter (in mils) of any circle will give its area in circular mils. One circular mil = .7854 square mils. To reduce square mils to circular mils, multiply by 1.2732.

In connection with the use of the B. & S. (American) gauge, it may not be generally known that with every three sizes the cross section is doubled approximately. Thus No. 4, for instance, is very nearly twice as large in cross section as No. 7 and half as large as No. 1. The error is only one-quarter of one per cent. This rule applies to the whole range of numbers.

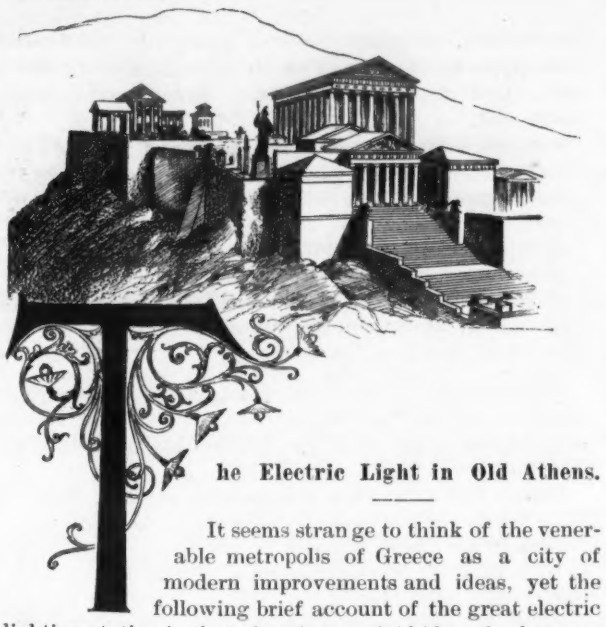
It might also be added here that the list of diameters of the B. & S. gauge numbers, as usually published, has a number of errors, two of which are not small. The corrected sizes were used in the accompanying table.

TABLE OF ALL THE POSSIBLE COMBINATIONS OF NOS. 00, 0, 1 AND 2 B. & S. WIRES HAVING A COMBINED CROSS SECTION OF LESS THAN 500,000 CIRCULAR MILS.

B. & S. (American) gauge numbers.	Combined cross section in circular mils.	B. & S. (American) gauge numbers.	Combined cross section in circular mils.	B. & S. (American) gauge numbers.	Combined cross section in circular mils.	B. & S. (American) gauge numbers.	Combined cross section in circular mils.
00-00-00-00	532,316	00-0-1-2-2	455,053	2-2-2-2-2-2-2	398,238	1-1-2-2	300,134
0-0-0-0-0	527,670	0-1-2-2-2-2	454,720	00-0-1-2	388,680	0-0-1	294,762
1-1-1-1-1-1	502,164	00-1-1-1-2	450,534	0-1-2-2-2	388,347	00-1-2	283,146
00-00-1-1-2	499,919	1-1-1-2-2-2	450,201	00-1-1-1	384,161	1-2-2-2	282,813
00-1-1-2-2-2	499,586	00-0-0-0	449,681	1-1-1-2-2	383,828	0-0-2	277,441
1-1-2-2-2-2-2	499,253	0-0-0-2-2	449,348	0-0-0-2	382,975	0-1-1	272,922
00-0-0-1-2	494,214	0-0-1-1-2	444,829	0-0-1-1	378,456	00-00	266,158
0-0-1-2-2-2	493,881	0-1-1-1-1	440,310	00-00-0	371,692	00-2-2	265,825
00-0-1-1-1	489,695	00-00-0-2	438,065	00-0-2-2	371,359	2-2-2-2	265,492
0-1-1-1-2-2	489,362	00-0-2-2-2	437,732	0-2-2-2-2	371,026	0-1-2	255,601
0-0-0-0-2	488,509	0-2-2-2-2-2	437,399	00-1-1-2	366,840	1-1-1	251,082
1-1-1-1-1-2	484,843	00-00-1-1	433,546	1-1-2-2-2	366,507	00-0	238,613
0-0-0-1-1	483,990	00-1-1-2-2	433,213	0-0-1-2	361,135	0-2-2	238,280
00-00-00-1	482,931	1-1-2-2-2-2	432,880	0-1-1-1	356,616	1-1-2	233,761
00-00-1-2-2	482,598	00-0-0-1	427,841	00-00-1	349,852	00-1	216,773
00-1-2-2-2-2	482,265	0-0-1-2-2	427,508	00-1-2-2	349,519	1-2-2	216,440
1-2-2-2-2-2-2	481,932	0-1-1-1-2	422,989	1-2-2-2-2	349,186	0000	211,600
00-00-0-0	477,226	0-0-0-0	422,136	00-0-0	344,147	0-0	211,068
00-0-0-2-2	476,893	1-1-1-1-1	418,470	0-0-2-2	343,814	00-2	199,452
0-0-2-2-2-2	476,560	00-00-1-2	416,225	0-1-1-2	339,295	2-2-2	199,119
00-0-1-1-2	472,374	00-1-2-2-2	415,892	1-1-1-1	334,776	0-1	189,228
0-1-1-2-2-2	472,041	1-2-2-2-2-2	415,559	00-00-2	332,531	0-2	171,907
00-1-1-1-1	467,855	00-0-0-2	410,520	00-2-2-2	332,198	000	167,895
1-1-1-1-2-2	467,522	0-0-2-2-2	410,187	2-2-2-2-2	331,865	1-1	167,388
0-0-0-1-2	466,665	00-0-1-1	406,001	00-0-1	322,307	1-2	150,067
00-00-00-2	465,610	0-1-1-2-2	405,668	0-1-2-2	321,974	00	133,079
00-00-2-2-2	465,277	1-1-1-1-2	401,149	1-1-1-2	317,455	2-2	132,746
00-2-2-2-2-2	464,944	0-0-0-1	400,296	0-0-0	316,602	0	105,534
2-2-2-2-2-2-2	464,611	00-00-00	399,237	00-0-2	304,986	1	83,694
0-0-1-1-1	462,150	00-00-2-2	398,904	0-2-2-2	304,653	2	66,373
00-00-0-1	455,386	00-2-2-2-2	398,571	00-1-1	300,467		

The Pittsburgh Electric Club.

Pittsburgh, Pa., now being one of the foremost cities in the practical application of electricity and the home of one of our largest parent electric companies, an Electric Club has been organized upon the lines of the New York and Chicago Electric clubs. The scheme has been pushed principally by attachés of the various parent electric companies represented in Pittsburgh, and all the branches of the business are well represented. The Westinghouse Electric and Manufacturing Company is represented by Francis P. Mann, of the laboratory; James A. Rutherford and H. McL. Harding, of the railway department; Ernest Heinrichs, of the advertising department; Lewis W. Robinson, of the lighting department, and others; the Thomson-Houston Electric Company by Henry Fleetwood Albright, local agent; D. W. Dunn, E. B. Gawthrop and others; the Edison General Electric Company by E. B. Kittle, I. H. Silverman and others; and the Fort Wayne Electric Company by Eugene Ingold and J. E. Hall. The president chosen is connected with no commercial company, being Mr. Morris W. Mead, chief of the city Bureau of Electricity. The directors are: H. McL. Harding, Westinghouse Company; D. W. Dunn, Thomson-Houston Company; I. H. Silverman and E. B. Kittle, Edison Company; H. E. Dillon, chief of Allegheny Bureau of Electricity; Eugene Ingold, Fort Wayne Company; E. B. Gawthrop, of Messrs. Hughes & Gawthrop, local representatives of the Thomson-Houston Company. James A. Rutherford, of the Westinghouse Company, was elected treasurer, and J. E. Hall, of the Fort Wayne Company, secretary. The location of the rooms has not yet been decided upon. The coöperation of the New York and Chicago clubs is invited.



The Electric Light in Old Athens.

It seems strange to think of the venerable metropolis of Greece as a city of modern improvements and ideas, yet the following brief account of the great electric lighting station in that city gives a vivid idea of what new Greece and the Athens of to-day really are.

The first electric light plant in the city of Athens was installed in September, 1888, under the auspices of the Société Générale d'Enterprises. It was intended only for the temporary lighting of the Greek National Exhibition, then in progress, and consisted of 50 arc lights and 60 incandescent lights. The electrical material was obtained from the Paris Edison Company, and for the purpose of installing it that organization sent their expert engineer, M. Etienne de Fodor, to whom the development of electric light in Greece is very largely due. He, fortunately, had previously had large experience in managing installations in all sorts of out-of-the-way places, and had been connected with the electrical industry almost from its beginning. In 1882 he installed the first electric light plant in Belgium; a little later, in Tamerforse, he installed the first electric light plant in Russia, in a cotton mill, and still later put in the first plant in Algeria. With this experience of working in unwonted places M. de Fodor undertook the electric lighting of Athens. The introduction of the preliminary plant was a success, and in the same year the new theatre and the hotel de la Grande Bretagne, the largest in Athens, were also equipped with the electric light. Both these were operated from a single station temporarily put up and de-

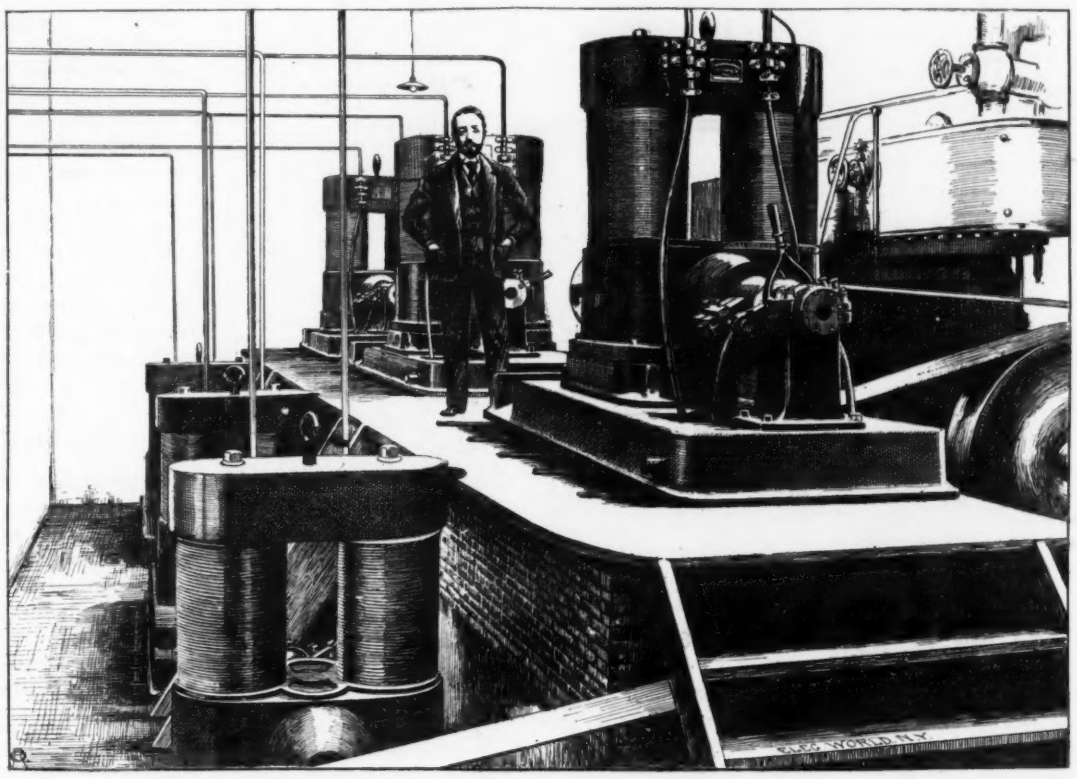


FIG. 1.—DYNAMO ROOM OF THE ATHENS CENTRAL STATION.

riving its power from locomotive boilers. Before long the electric light became so popular, and the number of subscribers had so increased, that it was necessary to erect two little improvised stations, which were in operation about a year. In 1889 larger facilities and a more extensive plant became absolutely necessary, and in August of that year the foundation of the present great central station was laid, and three months afterward the new plant went into operation. The number of subscribers for the light was not very large, but public sentiment appreciated the advantages of the new illuminant, and very soon a large part of the city was being supplied with light from this station. The details are given in our illustrations Fig. 1 shows the dynamo room; in it are at present installed six large dynamos, made by the Compagnie Continentale Edison. They are of 120 volts and 500 ampères capacity each, and are coupled in pairs, each pair being driven by a single 150 h. p. engine; there are thus three independent groups. The day service, which has now grown to a considerable amount, is operated by four more Edison dynamos of 120 volts and 240 ampères each. Each of these machines is driven by a separate engine. The total capacity of the station is now in the neighborhood of 475,000 watts. As an additional reserve, in case of need, a battery of 130 Julien accumulators is employed, with an aggregate capacity of 800 ampère-hours.

The engines, well shown in Fig. 2, are for the regular service, and are three compound vertical engines of the Pelong type, of 150 h. p. capacity each, at 170 revolutions per minute. They are manufactured by Heyher & Richmond, of Paris. The day service, as noted before, is taken care of by separate machines, four in number, of 35 h. p. each. The total capacity of the engines is, therefore, 590 h. p. As water for condensation is not convenient in Athens the machines are run non-condensing. Some experiments with air condensation have been tried, but have led to no successful results. Only half the engines are run continuously at present; the other half are held in reserve. The steam for these engines is furnished from a battery of Babcock & Wilcox boilers of Scotch manufacture. These are grouped in pairs, with a joint capacity of 7,000 kilograms of water per hour and a heating surface of 468 square metres. They are fed by Worthington pumps. The feed water is drawn through pipes two kilometres long from the bed of the classical Ilissus. In summer this supply is somewhat short, and the water has to be obtained from a still greater distance. So much for the plant itself.

The distribution is on the Edison three-wire system, each pair of dynamos feeding separate mains. The full system of feeders is not yet up, and the switchboard is of rather a temporary character, and will be replaced later by an elaborate structure of marble from the famous quarries of Pentelicus. The present arrangement is well shown in Fig. 3. There is an ampèremeter and voltmeter for each dynamo, another ampèremeter for each feeder, and switches for each dynamo and feeder, and two general ampèremeters for a full load, beside the various other

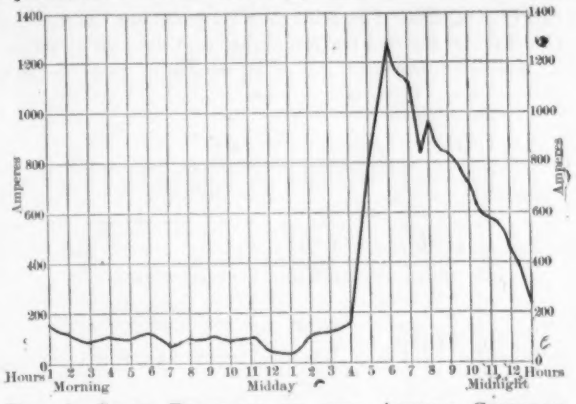
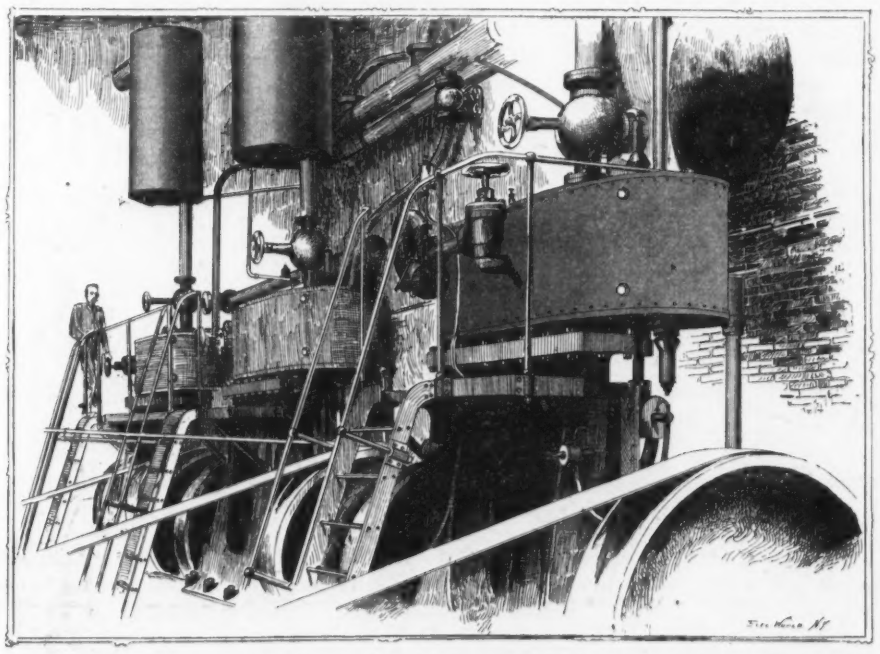
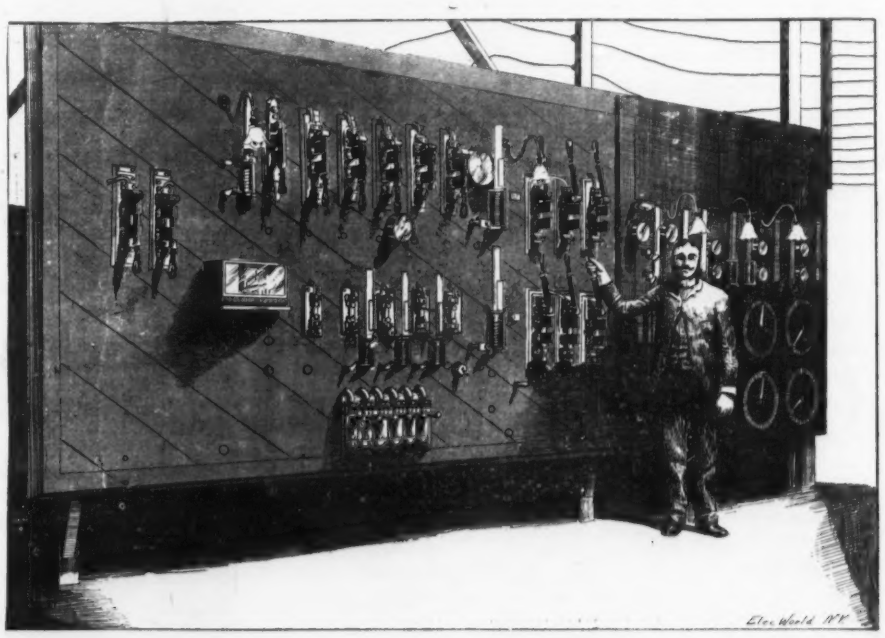


FIG. 4.—LOAD DIAGRAM OF THE ATHENS CENTRAL STATION.

central station instruments. The operation of the station is continuous. The period of heavy load is from four o'clock in the afternoon to about one in the morning. The light load extends, then, over the remaining hours of the twenty-four. During the latter period the small output for lamps and motors is taken care of partly by the accumulators and partly by the small dynamos just mentioned. In the afternoon this load is shifted on the main circuits. The larger part of the distribution is carried through the city sewers. The capacity of these sewers for carrying off the rain-water is so great that the wires can be carried through them upon porcelain insulators. Overhead lines are not used to any extent. The main feeders, each having a cross-section of 150 millimetres, are composed of four bare copper wires grouped together, and insulated with Edison insulating compound. Where no sewers exist lead cables run in asphalted wood conduits are employed. For outlying districts some overhead lines are employed, of a total length of three kilometres. Each subscriber is protected by a fusible plug located in the sewer, and by a second local cut-out, which is usually Edison's porcelain triple cut-out. Edison meters are employed for the entire service of the central station. Athens after Milan is the second city on the Continent to employ these meters in industrial use. The price is 12 lepta per ampère hour about 2.4 cents.

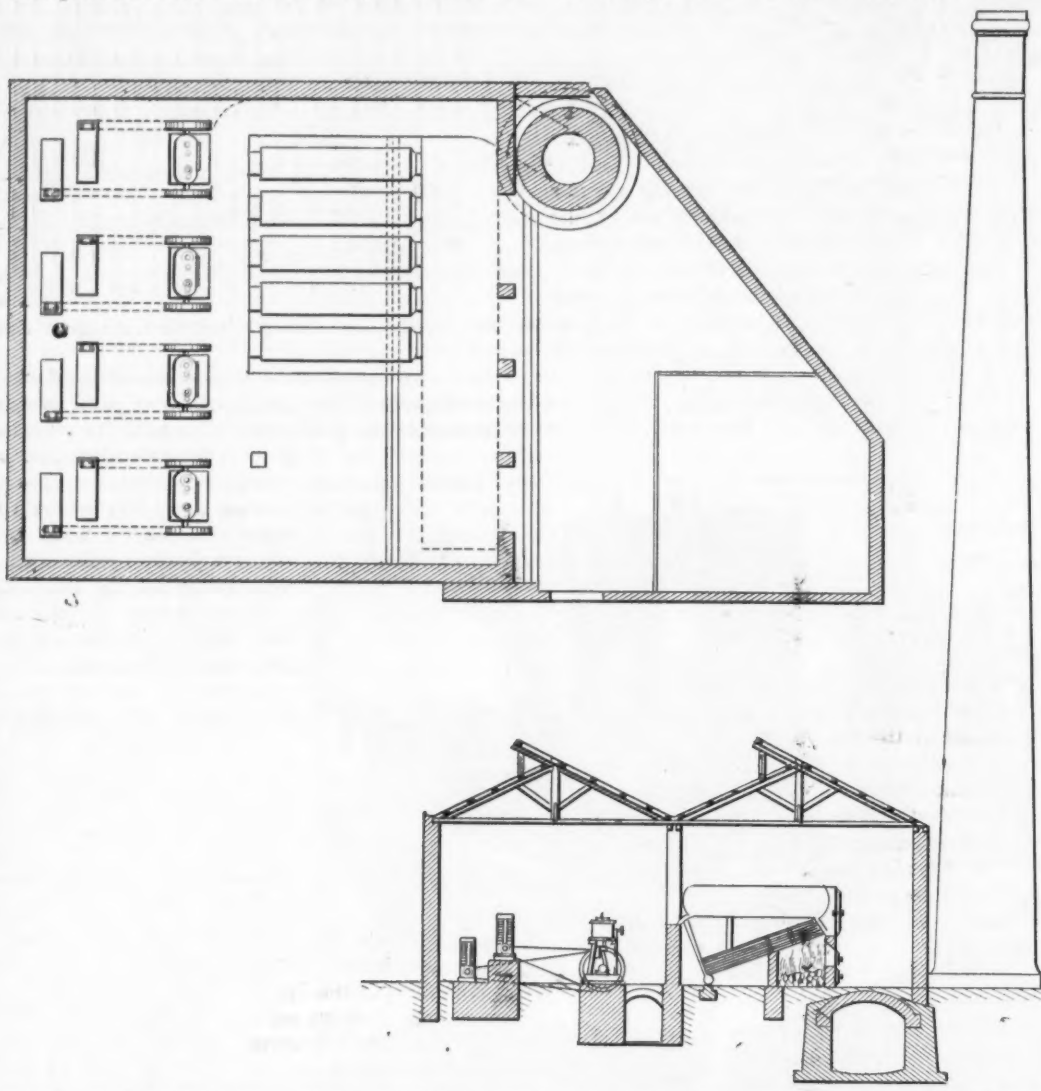
Throughout the entire equipment of the station American goods are largely used, and prove to be better and cheaper than goods of European manufacture. One will find American incandescent lamps, sockets, cut-outs, insulating compounds, switches and the like. M. de Fodor is a disciple of American engineers, especially of Mr. Batchelor, and is one of the first of the European electricians to appreciate the advantages of American electrical supplies. On this and the next page will be found figures showing the load diagram for the 24 hours and the plan and elevation of the station. One noticeable feature of the plan is the disposition of the dynamos with respect to the engines. Half the dynamos are upon a platform, so that in spite of somewhat contracted quarters every portion of the machinery is thoroughly accessible. The stack is seen





FIGS. 2 AND 3.—ENGINE ROOM AND SWITCHBOARD OF THE CENTRAL STATION AT ATHENS, GREECE.

to be a very prominent feature, towering over the building to a height of about 170 feet; the diameter at the base is about seven feet, and a trifle less at the top; the thickness of the walls being about three ft. Altogether this central station at Athens is an excellent example of a Continental central station plant, and reflects great credit on the enterprise and skill of M. de Fodor, who has so successfully accomplished the difficult task of introducing the electric light in an entirely new field among people by no means familiar with the applications of electricity, and isolated from most electrical establishments. From all appearances the demand for electric light in Athens is growing with considerable rapidity, and it probably will not be long before this station will be loaded up to its full capacity, and further increase will become necessary. It is especially to be noticed that the motor service is gaining headway, and probably ere long the ancient city of the philosophers will be lighted throughout by means of the fluid they were kind enough to christen, and it may even be possible for the Athenian of to-day to go to his place of business at the foot of the Acropolis upon electric cars. The later days have come and modern ideas with them.



PLAN AND SECTIONAL ELEVATION OF THE LIGHTING STATION AT ATHENS, GREECE.

Statistics of Electric Lighting in Massachusetts.

The sixth annual report of the Board of Gas and Electric Light Commissioners of Massachusetts for the year ending June 30, 1890, which has just been issued, contains a very great amount of information concerning the condition of both public and private lighting in that State. During the year 11 new companies were incorporated, with an aggregate capitalization of $282,000. The total results of the year's operation of the electric light central stations were as follows:

Receipts:	
For light and power	$1,908,394.00
From other sources	12,308.05
	$1,920,702.05
Expenses:	
For manufacture	$752,831.18
For distribution	281,046.33
For office expenses and management	116,350.92
For taxes	67,620.91
For miscellaneous	122,965.26
	$1,340,814.60
Leaving a balance of	$579,887.45

These figures show the earnings of electric light companies and of the electric light departments of gas companies. The amount of net earnings of the electric light departments of gas companies was $110,871.40, leaving as the net earnings of the electric companies $469,016.05 applicable to the payment of interest and dividends. The total capitalization of companies in active operation at the end of the year was $5,471,325. The total number of stockholders of the electric light companies was 2,310, and of this number 1,969 were residents of Massachusetts. In the number of stockholders the Boston Electric Light Company leads the list with 362, while the Lowell Electric Light Corporation has 318. In capitalization the Edison Electric Illuminating Company of Boston heads the list with $1,160,000, this stock being held by 77 stockholders, 66 of whom reside in Massachusetts. The total valuation of the electric plants as made by the local assessors was $1,053,950. Fifty-one companies have bonds outstanding to the amount of $2,082,945. Dividends were paid by 22 companies, amounting to $154,708. These ranged from a ten per cent. dividend in the case of the Pittsfield Electric Light Company to one of one and one-half per cent. paid by the Woburn company. The six per cent. dividend of the Boston Electric Light Company made the largest paid by any one company, amounting of $60,000.

The largest arc light company in the State is the Boston Electric Light Company, with 3,020 arc lights of 2,000 c. p., besides 5,340 incandescents of 16 c. p. The Edison company of Boston leads the list in incandescent lighting with 25,600 lights of 16 c. p., supplied from 77 dynamos.

The total number of boilers in use in central stations was 200. These furnished steam to 250 engines. The total number of dynamos in use was 500. Three plants use water power exclusively and three others use both water and steam power. The returns for fuel consumption show that the greatest amount of coal burned was in the stations of the Boston Electric Light Company, amounting to 16,589 tons, the Boston Edison company coming next with 8,000 tons. One plant is operated entirely by three 15 h. p. gas engines, the consumption of gas being 1,202,990 feet. This plant has a capacity of 70 arc lights of 1,200 c. p. each. One plant bought its steam and in two the power was leased.

The following table shows the number of electric lights in operation of various candle power, represented by the dynamo capacity of the plants:

C. P.	1888.	1889.	1890.
16	52,075	80,075	140,870
20	1,200	2,800	1,700
15	880	880	880
2,000	5,846	6,978	8,425
1,200	2,757	4,206	6,085
1 600	110	130	60
1,500		35	60
1,800		40	40
800		140	70

The report shows a net loss of 1,776 public gas lamps as against a loss of 999 in the previous report, these having been displaced by electric lamps. The total number of gas meters in use in the State is 104,506.

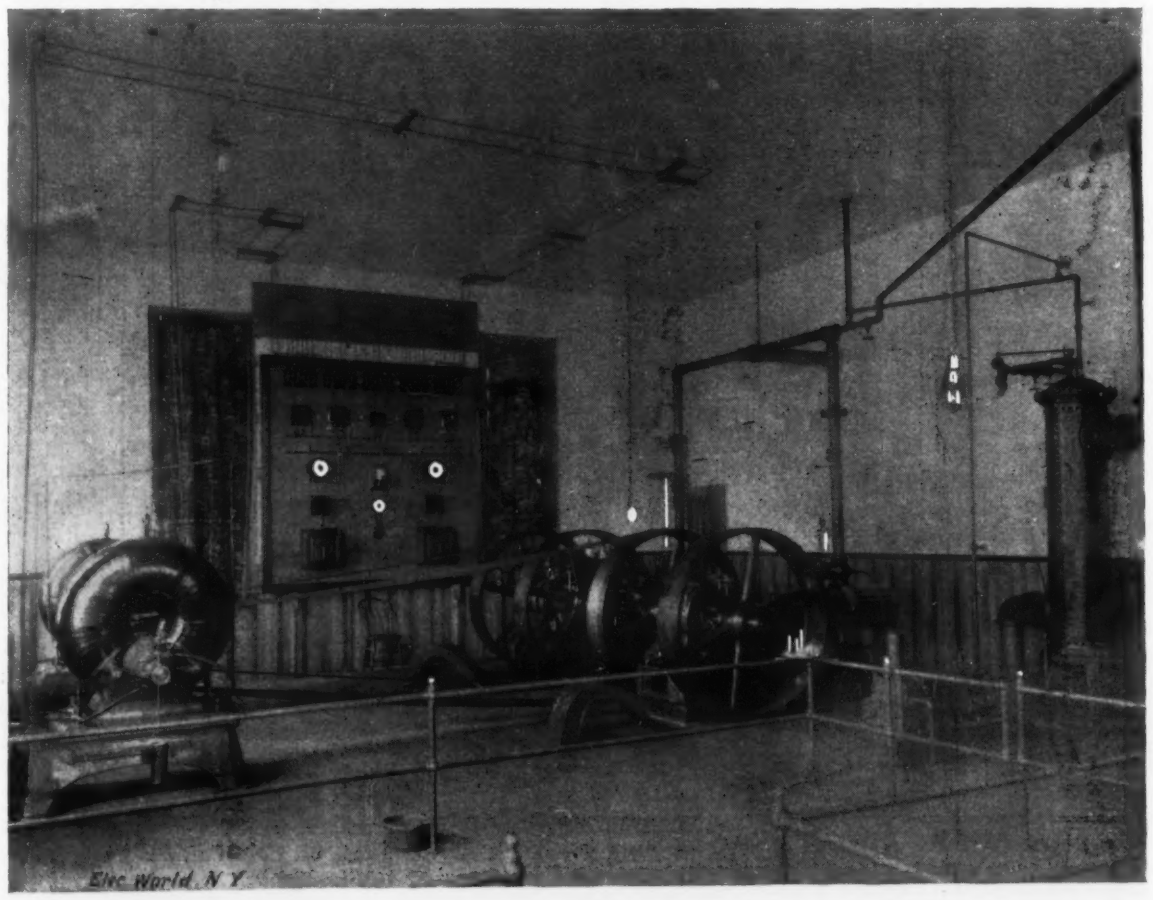
During 1890 there were five persons injured, three of them fatally, by electricity, while during the same period 23 persons have been injured by illuminating gas, eight of them fatally. The total number of deaths by inhaling illuminating gas in the United States in 1890, as reported to the Board from various sources, was 174, 35 of these being suicides.

Electric Tramway at Rome.

The work of installation of the electric tramway to connect the Place del Popolo and the Ponte Mollo, at Rome, is complete, and the line, about one and a half miles in length, has been started. Two 60 h. p. engines drive two Statter series dynamos, giving 52 ampères at 850 volts, one set being for reserve. The overhead line of four silicon bronze wires is carried 22 feet above the ground. There are three cars, each carrying a 15 h. p. series motor, and regulation is obtained by a shunt resistance. The line is run in sections in series, automatically worked by the passing cars. The introduction of the resistance of one-tenth of an ohm in the motor circuit is sufficient to reduce the power of the motor to 4 h. p.

Municipal Plant at Webster City, Ia.

The plant at Webster City, Ia., including pole line, wire and all accessories, is owned and operated by the city. As will be seen upon reference to the accompanying illustration, the dynamos are of the Mather Electric Company's manufacture, compound wound, and are rated at 500 lights nominal capacity. Steam is furnished by two 80 h. p. boilers to two 60 h. p. high speed Phœnix engines. The plant was first started Nov. 17, 1890, and at the present time operates 1,024 commercial and domestic lights and 90 32 c. p. street lamps from dark to daylight. These latter are suspended over the centre of the streets. The plant is somewhat remarkable, from the fact that a portion of the lights are operated three-fourths of a mile from the station upon a 112-volt, two-wire circuit, with a loss of less than 10 per cent.



ENGINE AND DYNAMO ROOM OF THE WEBSTER CITY (IA.) LIGHTING STATION.

The switchboard is so arranged that the circuits are perfectly independent of each other, and can be easily controlled by the attendant in charge.

The building occupied was intended originally for the exclusive use of the electric machinery, but after its erection it was decided by the city authorities to locate the water works in the same buildings. The station offers an example of cleanliness and neatness which could be advantageously followed by many of its kind.

Inductive Disturbances in Telephone Circuits.*

BY J. J. CARTY.

It was not known until 1838 that the earth might be used instead of a return wire in the circuit of a telegraph line. This fact was discovered by Steinheil while making experiments to determine whether the track of a railroad could be used to complete the circuit instead of a return wire. Steinheil's discovery has been considered as one of the most important in the art of telegraphy, and since his time it has been the almost universal practice to use the earth as a return in telegraph circuits. When, however,

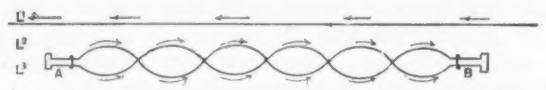


FIG. 1.—ARRANGEMENT OF WIRES FOR AVOIDING INDUCTION.

the earth return is used with the telephone, it is found that, owing to the extreme sensitiveness of that instrument, many foreign currents, which would produce but little effect on telegraph instruments, become a source of serious trouble. For this reason, in telephony it is often necessary to use a complete metallic circuit. Thus it has come to pass that a return to the original practice of employing metallic circuits, as in the case of the crudest telegraph instruments, is now regarded as a most important improvement in connection with that most highly developed of telegraph instruments, the telephone.

To obtain complete freedom from inductive disturbances in the telephone, it is necessary not only to use a metallic circuit, but to place the two wires composing the circuit in a special relation to the source of disturbance.

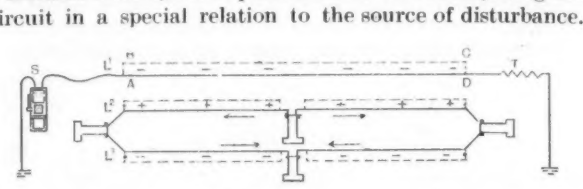


FIG. 2.—CARTY'S EXPERIMENTS ON INDUCTION INTERFERENCE.

One of the methods of so arranging the wires is shown in Fig. 1.

In this case the two sides of the circuit, L^2 and L^3, are twisted spirally about each other, so that their average distance from the disturbing wire, L^1, shall be the same. With such a plan, the telephones, A and B, are not affected by induction from the wire L^1. This fact has usually been explained by assuming that a current commencing to flow in L^1 tends to induce two currents in the opposite direction to itself, one in the wire L^2 and the other in the wire L^3; that both currents are of the same strength because the average distance of L^2 and L^3 from the disturbing wire, L^1, is the same; and that the telephones, A and B, are silent because they are acted upon by two equal and opposite forces. The above theory seems at first sight correct, and

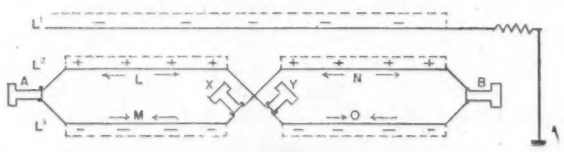


FIG. 3.—CARTY'S EXPERIMENTS ON INDUCTION INTERFERENCE.

indicates the line of explanation adopted in many works treating of the subject.†

I have made a number of experiments which seem to prove that, in the case described, the inductive action, instead of tending to produce a simple current in each side side of the metallic circuit, actually does produce a number of different currents in each wire and in both directions.

In Fig. 2, L^2 and L^3 are two well-insulated copper wires 500 feet long and three feet apart. These wires are joined together at each end through an ordinary telephone. L^1 is a well-insulated wire similar to the other two and placed within one-half an inch of L^2. At one end of L^1 is placed a Blake transmitter, T, and at the other end is placed a subscriber's bell, S, L^1 being grounded at both ends as shown. When the transmitter, T, is operated, either by

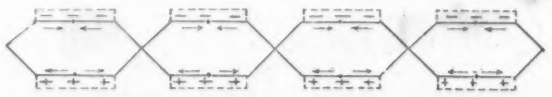


FIG. 4.—CIRCUIT CONTAINING THREE TRANSPOSITIONS.

speaking into it or by vibrating a powerful tuning-fork in front of it, disturbances are produced at the end telephones.

If telephones are inserted at the centre of L^2 and L^3 it is found that at those points no sound is heard, while the noise of the end telephones continues as before. This constitutes a simple case of inductive disturbance, and can only be explained by assuming that the wire L^1 acts electrostatically upon the circuit composed of L^2 and L^3, or, in other words, that we are dealing with a system of condensers in series, of which L^1 constitutes one plate, the earth another, and the wires L^2 and L^3, two intermediate plates, which are joined together through the end telephones.

Let us assume that at a given instant the height of potential along the wire L^1 is represented by the lines $A\ B$ and $C\ D$, and the charge upon L^1 by the rectangle $A\ B\ C\ D$. The presence of this charge, which we will say is of the minus sign, is accompanied by an equal but plus charge on L^2. This produces a minus charge on the wire L^3, which in turn acts upon the earth. Now we will assume that the potential on L^1 is reduced to zero. This causes a restoration of the equilibrium in the circuit composed of L^2 and L^3, which is accompanied by a set of currents as represented by the arrows. The plus charge on L^2, flowing through the end telephones, neutralizes the minus charge on L^3, thus leaving a neutral point at the centre of each of the wires L^2 and L .

In this and the succeeding experiments the induced charges are represented by rectangles. This is not a strictly accurate method, but as an error in this respect only affects the result quantitatively, and cannot alter the conclusions, I have adopted it on account of the simplicity of treatment which it permits.

The potential along the wire L^1 at a given instant is

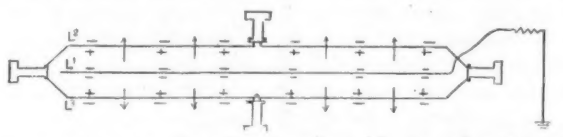


FIG. 5.—CARTY'S EXPERIMENTS ON INDUCTION INTERFERENCE.

represented as being constant, as it is found that owing to the high impedance in the instrument S, there is practically no fall of potential in the wire itself. Furthermore, it was found in the experiments about to be described that the results were the same whether the disturbing wire was open or connected to earth through the bell S. There would be a fall of potential along the wire L^1 if it were of such a length as often found in practice, and the distribution of the charge would be modified accordingly. But as this fact would only affect the location of the neutral points, the question of the fall of potential will not be taken into consideration, and the disturbing wire will be shown open at one end.

Fig. 3 shows the same circuits as used in the previous experiment, except that the wires L^2 and L^3 are caused to

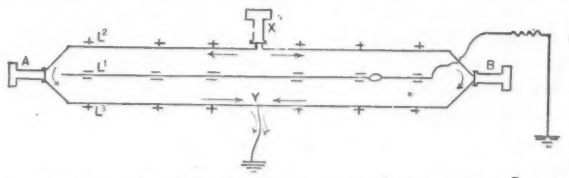


FIG. 6.—CARTY'S EXPERIMENTS ON INDUCTION INTERFERENCE.

change places at their centres, but are continued in the same plane, as in Fig. 2. This is what is called a "transposition." The telephones at the ends and in the middle are retained as before. Under these conditions, when the transmitter is operated, a diminished sound is heard at A and B; and X and Y, instead of being silent as in the first case, now emit a sound of the same intensity as A and B. When telephones are placed at the quarters L, M, N, O, the sounds at $A\ B$ and $X\ Y$ continue as before, but nothing is heard at L, M, N, O. The effect of this one transposition has been to reduce the disturbance at the end telephones A and B, and to cause a shifting of the neutral points from the centres to the quarters, and an increase of their number from two to four.

An examination of the induced charge shows how these

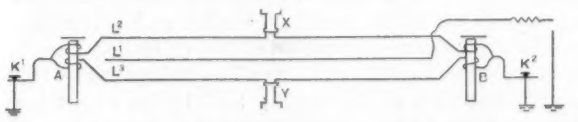


FIG. 7.—CARTY'S EXPERIMENTS ON INDUCTION INTERFERENCE.

results have been brought about. It will be seen by reference to Fig. 3 that there is on the first half of L^2 a positive charge, and on the second half a negative charge, and on the first half of L^3 a negative charge, and on the second half a positive charge. When the positive charge on L^2 discharges, half of it goes through the telephone A and half through the telephone Y. The positive charge on L^3 escapes in a similar manner, half going through telephone X and half through telephone B. This produces four currents, two starting from the point L and two starting from the point N. One of the currents from L meets a current at O, coming from the point N, and one of the currents starting at the point N meets a current at M, which started from L. The currents flowing through the end telephones in this case are not so strong as when no transposition is employed, because they are due to an induced charge which is represented by an area half as great. It is found that as the number of transpositions is increased the number of neutral points is also increased, and that the area representingrthe charge which escapes through the end telephones is reduced. To obtain silence, therefore, it is necessary to increase the frequency of transpositions until the discharge through the end telephones is so small as not to produce sounds therein. Fig. 4 shows a circuit containing three transpositions, one at the centre and one half way between the centre and each end. In this case, if we could neglect the resistance of the telephones, the current going through the ends would be reduced to one fourth of its original proportions, and eight neutral points would be produced, one in each wire at the centre of each transposition.

In practice the impedance of the telephones must be taken into consideration, so that if in Fig. 3 the middle telephones X and Y were omitted, the neutral points would be found to move toward the ends, and the currents flowing

FIG. 8.—CROSS SECTION OF WIRES SHOWN IN FIG. 1.

through the end telephones would be correspondingly reduced.

According to this theory of transpositions, if the instruments and distances between wires on a given circuit remain constant for a given period of alternations in the disturbing wire, the number of transpositions necessary to obtain silence will depend on the E. M. F. of the disturbing wire, and the specific inductive capacity of the dielectric. An increase in the value of either of these factors will, if silence is to be maintained, require additional transpositions, their number depending upon the value of the change which is made.

Where the disturbing wire is placed at an equal distance from both sides of the metallic circuit, no noise is produced

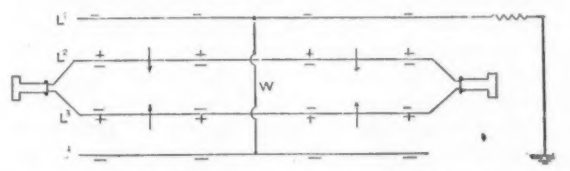


FIG 9.—CARTY'S EXPERIMENTS ON INDUCTION INTERFERENCE.

in telephones located in that circuit, and a balance once being obtained, it is independent of both the E. M. F. of the disturbing wire and the specific inductive capacity of the dielectric. Fig. 5 shows such an arrangement of circuits —L^2 and L^3 are the two wires composing the metallic circuit placed the same distance apart as before, and the disturbing wire is an equal distance from both. When the disturbing wire is in operation, no sound is heard at the end telephones, or at telephones located at the centres. This may be accounted for by assuming that at a given instant a negative charge is on the disturbing wire, which produces a positive charge on the inside of L^2 and L^3 and a negative charge on the outside of those wires; and that when the charge is removed from the disturbing wire a set of currents is set

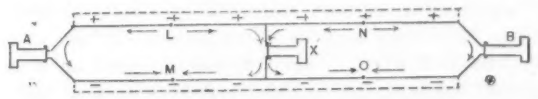


FIG. 10.—CARTY'S EXPERIMENTS ON INDUCTION INTERFERENCE.

up in the wires L^2 and L^3 in a direction at right angles to their axes, as shown by the arrows. In this case the flow is lateral, and no current passes through the end telephones or through telephones located at the centres. It will thus be seen that this method of arranging wires differs essentially in its action from the plan of using transpositions. Unfortunately, however, its practical application is limited to two circuits.

Where the disturbing wire occupies the position shown in Fig. 5, the flow in the conductors is lateral only when the wires L^2 and L^3 are insulated from the earth. If a ground be attached to the centre of L^3, as shown in Fig. 6, the flow of current becomes longitudinal, and the telephones A and B are found to be affected by loud disturbances, while the telephone X, at the centre of L^2, is found to be silent. This is because the disturbing wire, which we

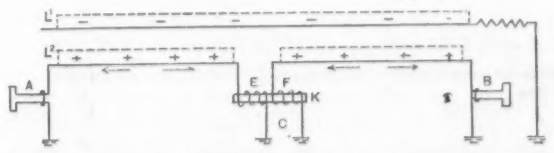


FIG. 11.—CARTY'S EXPERIMENTS ON INDUCTION INTERFERENCE.

will say is negatively charged, induces a positive charge upon L^2 and L^3 and a negative charge upon the earth. The discharge in this case is effected by two currents starting from X, which thus becomes a neutral point, and passing through the end telephones to the ground as shown by the arrows. If the ground be removed from the point Y toward the telephone A, the neutral point will be found to move toward telephone B, and if the ground be put at the centre of resistance of the telephone A, the neutral point will be found to be at the centre of the telephone B. This is well illustrated in Fig. 7, where A and B are telephones of special construction, admitting of the attachment of grounding keys K^1 and K^2 at their respective centres. In this instance, when the disturbing wire is in operation and both keys open, no sound is heard at any of the telephones, the flow of current being lateral,

*A paper read before the American Institute of Electrical Engineers, March 17, 1891.

†"A Handbook of Practical Telegraphy," R. S. Culley, 1885, p. 330; "The Telephone," Preece & Maier, 1889, p. 134; "Die Technik des Fernsprechwesens," Dr. V. Wietlisbach, 1886, p. 135.

If the key K^1 be closed, sound is immediately heard at telephones X and Y located at the centres of L^2 and L^3, but the telephones A and B are still silent. This is because the charge and discharge take place along the conductors L^2 and L^3 to and from the earth at K^1, thus passing through X and Y, A being silent because the currents go through it differentially, and B is silent because it is located at a neutral point. To prove that current flows through telephone A, another telephone may be inserted in the ground branch at K^1, and it will be found to be loudly affected. If both keys K^1 and K^2 are closed, silence is again obtained in the four telephones A, B, X, Y. In this case the charge and discharge from the wires L^2 and L^3 divide at the centre and flow back and forth at both ends, X and Y being silent because they are at neutral points, and A and B are not affected by the currents which flow through them because of the differential action referred to.

Two systems have now been described, one in which the induced current is lateral, and the other in which it is longitudinal. I think it follows from the foregoing experiments that where wires are twisted about each other as shown in Fig. 1, both of these actions are combined. At the left hand of Fig. 8, a cross-section of the three wires L^1, L^2 and L^3 (Fig. 1) is shown. In this position the wires occupy a place with reference to each other exactly as in Fig. 2, and the tendency of the disturbing wire is to cause a longitudinal flow in L^2 and L^3. If repeated cross-sections of these wire are made, a point will be reached at which the three wires are disposed as shown at the right hand of Fig. 8, where it is seen that the disturbing wire L^1 is at an equal distance from L^2 and L^3, and the tendency is to produce a lateral flow. The actual currents produced must be the resultant of these two actions.

Fig. 9 shows a plan quite different in principle from anything heretofore employed. It is of interest not so much on account of any practical application which it may have at present, but because it is a very striking proof of the electrostatic nature of induction crosstalk between telephone circuits. L^1, L^2 and L^3 are the same wires as used in the previous cases, L^1 being half an inch from L^2, with the addition of an extra wire L^4 placed half an inch from L^3 and joined by a conductor W with the disturbing wire L^1. L^2 and L^3 are three feet apart. When in this condition the transmitter is operated, no disturbance whatever is heard in the end telephones; if the wire W be disconnected, the usual noise is heard, but is found to disappear as often as L^1 and L^4 are joined together. This action is explained by the fact that L^4 is at the same potential as L^1, on account of being joined to it by the wire W, and acts with the same force on L^3 that L^1 does on L. The flow in this case is lateral, as indicated by the arrows; and the telephones are silent.

Neutral points may be produced in a circuit by the use of shunts. Fig. 10 shows the usual arrangement of circuits with the telephones A and B at the ends, and another telephone X, of equal impedance branched between the two wires at the centre. In this case four neutral points are found, two in each wire. The currents produced by the discharge are indicated by the arrows. Thus, by the addition of one shunt, the disturbing currents in the end telephones have been reduced one-half. If similar shunts were placed at the quarters, the currents at the end telephones would be still further reduced to one-quarter of their original strength.

This plan is not a practicable one because of its shunting effect on the telephone current, but is of value as showing one of the actions which occur when instruments are bridged into metallic circuits. It is interesting to note that in Fig. 10 the telephone X is affected by a current twice as great as that which flows through either of the end telephones.

Before closing I shall describe one more experiment. In Fig. 11, L^1 is the disturbing wire and L^2 is a grounded telephone circuit placed one-half an inch from L^1. At the centre of L^2 there is an ordinary telephone repeating coil or transformer C, containing two windings E and F of copper wire, each having a resistance of 160 ohms. One end of each winding is grounded, and the other end is connected to the line as shown. Assuming that the impedance of each telephone is equal to that of each coil of the transformer, a neutral point will be found at the centre of each half of L^2, and the disturbing currents flowing through the end telephones will be only half as strong as though the transformer were omitted. If now the connections of the transformer be reversed so that the discharges from the two sections of line pass through it in opposite directions, no magnetism will be produced in the core K, and consequently the transformer coils offer an easier path to the discharge. This causes the neutral points to move toward the end telephones and consequently reduces the disturbance still further.

I have not had an opportunity of trying this experiment with a transformer whose coils contained a low copper resistance and a high inductance, but according to theory, we might expect that such a transformer having its coils connected differentially should free a grounded line of considerable length from cross talk and other electrostatic disturbances. The number of such coils which can be worked in a given line is, of course, limited, but with properly designed apparatus a large number of them might be used. This arrangement is also interesting when considered with reference to electro-magnetic induction, and brings to mind a question as to whether we may not at some future time abandon the use of metallic circuits and again make use of Steinheil's discovery.

SUPPLEMENTARY NOTE, COMMUNICATED TO THE SECRETARY, BY THOMAS D. LOCKWOOD.

I understand that Mr. Carty's paper is to be read this month. If in that understanding I am correct, I regret exceedingly that it is not in my power to be present with you in a tangible form. It is moreover difficult to make a written communication upon a topic which as yet is unannounced, but as I have some reason to believe that Mr. Carty will speak upon the subject which he has largely made his own, I will have the temerity to hazard a word or two.

If Mr. Carty continues to hold the views of two years back, I understand him to believe that electrostatic in contradistinction to electromagnetic induction is chargeable with the major amount of discredit as an agency in disturbances on telephone lines; or at any rate, that it is a much more important agent in the development of such disturbance, whether noise or cross-talk, than has been supposed.

From long experience and observation, it appears to me that the several agencies in causing disturbing phenomena in telephone circuits which manifest themselves in the telephone receiver preponderate largely in accordance with the conditions of the circuit; that the environment (to use the language of social science) of a telephone circuit has a good deal to do with its behavior. Thus a line which has considerable leakage uniformly distributed throughout its length will suffer very little from electrostatic induction either manifested as a disturbance or as a retarding agency; not because the electrostatic induction is not exercised, or is not present; or to put it in a more modern and, I think, a more correct phraseology, not because inductive circuits are not formed, but because there being by virtue of the leakage or poor insulation an opportunity for a number of short cut or cross conductive circuits, these are utilized for the conduction of the electricity, permitting the establishment of equilibrium or discharge, at the expense of the utilization of the inductive circuits which tend to retain charge. The phenomena exhibited is comparable to a gallon vessel, say, into which liquid may be poured; but which has a number of holes bored through its sides. The vessel has a capacity of one gallon, but being leaky does not hold its charge, and the said charge is dissipated as quickly as it is formed. In this case, leakage tends, if accentuated, to become the chief adverse agency, as not only does a leaky circuit dissipate induced charges quickly, but it also permits stray currents which may disturb to come on the lines from external points.

As a matter of fact the several disturbances upon telephone lines are due to a large variety of causes. It is customary to say that the telephone is an extremely sensitive electroscope, or galvanoscope; and that it will take cognizance of almost infinitely small currents. This statement, however, should be made with some reservation.

The more correct statement is, of course, that the telephone is a sensitive indicator of *changes* in electrical currents.

A current may be caused to circulate through its helices which is sufficiently strong to make them warm, but if that current be steady, it will not be able to produce a sound in the telephone. Telephone disturbances then, broadly stated, can result only from changes which occur in the electric condition of the circuit within which the telephone is included, and these changes may be produced by conduction from other electrical organizations; by electromagnetic induction, sometimes brought about by changes going on in substantially parallel circuits, and sometimes caused by the mechanical motion of the disturbed circuit itself in a magnetic field, as when a line swings across the magnetic meridian of the earth; and by the successive charges and discharges which cause the alternate completing and disrupting of electrostatic inductive circuits.

If we exhaustively examine the literature of the subject we shall find that the idea that electrostatic phenomena are concerned in disturbances of telephone and telegraph circuits is by no means new. Mr. Culley presented a paper once upon this subject, before the Society of Telegraph Engineers; which paper, together with a most instructive discussion, is published in the journal of that society, and Mr. Preece and myself from time to time have also repeatedly referred to it. It is due, however, to Mr. Carty to say that his considerations and researches in this line show him to be an original and independent thinker and observer, and that I have found his work to be instructive in the highest degree.

I think, while he is undoubtedly right in attributing a large share of inductive disturbance in telephone lines, that he does not give sufficient weight to the equally undoubted fact that electromagnetic induction is also an important factor, and that, as I have already pointed out, the conditions of any individual circuit largely govern its action. An interposed plate or an envelope of metal between the disturbed and disturbing circuits will, if sufficiently thick, and if united to earth, screen so much of the induction as is electrostatic in its origin; but it will not screen electromagnetic induction, and thus whenever it is worth while the sources of inductive disturbances can be analyzed; and while the inductively neutral metallic circuit—the circuit with two wires closely adjacent and twisted together—is indeed a specific against electromagnetic inductive disturbance, it also tends to increase the retarding effect of electrostatic induction exercised between the two wires of the circuit.

Some of the considerations which tend to delay the universal employment of metallic circuits in telephony are, however, that there are an immense number of wires even when but one is used to a circuit; that twice the number of wires means twice the number to get out of order, to cross, break and leak, and consequently twice the number to take care of and handle.

I hardly think that sufficient thought is given to these matters by many who talk glibly about the necessity and essentiality of using metallic circuits only, for all classes of telephone work.

In conclusion, I wish to suggest, that inasmuch as the telephone only notes electrical changes, we cannot accurately say that sounds can be produced in it by electrostatic charge.

It is the fact that it is the motion caused in the act of forming and dissipating charge that produces the disturbing sound. But a charge in the act of formation or dissipation is practically a current; and as a current in the act of change, it necessarily varies also the magnetic field constituted by the circuit within which it is circulating; and as a further consequence therefore sets up in an adjacent and disturbed circuit electromagnetic induction currents. Thus the disturbing action is a compound one; operating first by the successive inductive charges and discharges induced in the disturbed circuit by the changes occurring in the disturbing circuit: and secondly, by electromagnetically induced currents developed in the disturbed circuit by changes in the magnetic field constituted by the disturbing circuit.

Transformer Formulæ.

At a recent meeting of the Physical Society of London a paper was presented on the "Proof of the Generality of Certain Formulæ Published for a Special Case by Mr. Blakesley; Tests of a Transformer," by Prof. W. E. Ayrton and Mr. J. F. Taylor. The following abstract of the paper is given by *The Electrician*, London:

In 1888 Mr. Blakesley published a number of formulæ relating to the measurement of power, etc., in alternating current circuits by means of electro-dynamometers, one of which had its two coils independent and placed in different circuits. These formulæ were deduced on certain assumptions, the chief ones being that the currents and magnetizations varied harmonically, and that the magnetic stress in the iron was proportional to the ampère turns. The present paper shows that the above assumptions are not necessary to the truth of the resulting formulæ. To take the case of a transformer, let alternating current ammeters be placed in the primary and secondary circuits, and a direct reading, "split dynamometer," have a coil in each circuit. Let D_p, D_s and D_{ps} be the respective readings of these instruments, then whatever be the law of variation of the currents,

$$D_p = \sqrt{\frac{1}{T}\int_0^T A^2_p \, dt}, \qquad D_s = \sqrt{\frac{1}{T}\int_0^T A^2_s \, dt},$$

and

$$D_{ps} = \sqrt{\frac{1}{T}\int_0^T A_p A_s \, dt},$$

Where A_p and A_s are the values of the primary and secondary currents at any instant, and T the time of one complete alternation. If i be the total induction in the core, P and S the numbers of turns of wire on the primary and secondary respectively, V_p and V_s the terminal pressures, p the resistance of the primary coil, and s the resistance of the whole secondary circuit, then the following equations hold at any instant:

$$V_p = p A_p + P\frac{d i}{d t}. \qquad \frac{d i}{d t} = \frac{s}{S} A_s$$

Therefore, $$V_p = p A_p + \frac{P}{S} s A_s.$$

Multiplying both sides by A_p we get $A_p V_p = p A^2_p + \frac{P}{S} s A_p A_s$ and integrating from $t = 0$ to $t = T$ and taking the mean

$$\frac{I}{T}\int_0^T A_p V_p \, dt = \frac{p}{T}\int_0^T A^2_p \, dt + \frac{P}{S}\frac{s}{T}\int_0^T A_p A_s \, dt$$

or watts in primary $= p D^2_p + \frac{P}{S} s D_{ps}$ quite independent of the laws of variation of A and V.

The power lost in heating the iron core was also shown to be

$$s\left(\frac{P}{S} D_{ps} - D^2_p\right).$$

Other formulæ, such as that given by Mr. Blakesley, expressing the primary volts in terms of the dynamometer readings, are shown to be true generally.

On the subject of transformer magnetizations, the authors state that it is desirable not to speak merely of the ampère turns, but also of the self-induction, for they have reason to believe that the magnetizing value of an ampère-turn varies. Defining the self-induction of the secondary by the equation $L_s = \frac{d N}{d A_s}$, N being the total flux through the secondary, they show geometrically (assuming harmonic variations) that if L_s diminishes the efficiency

increases, and at the same time the phase angle θ between the primary and secondary currents and the magnetic lag φ decreases. On comparing this theoretical deduction with the results of experiment, they find a good agreement, as will be seen from the following table:

Frequency.	Efficiency.	Ls	θ	φ
160	96.3%	.0017	113°	0° 24′
160	92.0	.0368	169	18° 24′
160	85.4	.1241	174.6	45° 36′

Similar results were obtained in different sets of experiments. It was also noticed that as the secondary current is increased the efficiency rises to a maximum and then diminishes, while L_s, θ, and φ diminish and then rise again; the current which gives the maximum efficiency coinciding almost exactly with that which gives minimum values to L_s, θ and φ.

The methods employed in making the tests are described in the paper, and the formulæ used in working out the results are there demonstrated. Amongst the facts deducible from the experiments are the following:

1. With constant frequency, the ratios $\frac{V_s}{V_p}$ and $\frac{D_s}{D_p}$ increase as the primary volts rise.

2. With frequency constant, and primary volts constant, $\frac{V_s}{V_p}$ decreases and $\frac{D_s}{D_p}$ increases as the secondary current increases.

3. With constant secondary current, L_s decreases as the primary volts are increased.

4. With small constant secondary currents the efficiency diminishes as the frequency increases.

5. For large secondary currents the efficiency is approximately independent of the frequency.

6. Shunting the secondary with a condenser increases the efficiency.

The Construction and Care of Electric Railroads: III. Erection of Feed and Trolley Wires.

BY ARTHUR E. COLGATE.

After the poles are set and properly guyed, the feed and trolley wires should be run, starting from circuit breakers which are firmly anchored to heavy poles either on the side of or between the tracks. These poles should be set very firmly in concrete to a depth of seven feet and have a rake of about ten inches. The feed wire should by spliced by means of soldered Western Union joints into lengths of about a mile to a mile and a half each, and wound on a large reel firmly mounted on a flat truck, sufficiently large to allow two or three men room to work comfortably. The end of the coil is attached to the circuit-breaker and about 60 feet run out, which is kept clear of the ground by passing it over a drum mounted on the tower used in setting poles. This follows the truck bearing the reel. The wire is kept sufficiently tight to prevent much sag between the poles by a wooden bar which is held against the side of the reel by two men. After a certain amount, depending on the size of wire, has been run out, it will be found difficult to keep it sufficiently tight to keep the slack clear of the ground. At this point a wire head guy should be run from the top of one pole to within ten feet of the base of the next. The feed is pulled tight by means of blocks and fall attached to the top of the pole and to the wire by a small chain or rope strap, which should be braided around it. After being pulled tight the wire is made fast to a pole back of the blocks, which has been previously guyed in the same manner, and the blocks and fall removed.

The line should then be tied in or fastened to the insulators with short tie pieces of wire by linemen, who go back over the line for this purpose, the tower and reel wagon keeping right ahead, paying out and hanging up wire. At the next pull up one man stays back and unfastens the strap, which holds the line after it is pulled sufficiently tight to prevent slack from running back into it through the ties.

Just before turning curves the line should be pulled tight and secured by straps, and should be again pulled up at the other end of the curve, but not quite to such a degree of tightness as the rest of the line. Where it is desirable to drop one feeder it should be secured to a circuit breaker which is fastened to a pole by means of a pendant and a turnbuckle or by an insulated turnbuckle. The largest feed wires are run before the smaller ones and on the pins nearest to the poles.

If it is thought necessary to run guard wires they should be made of steel not smaller than No. 5 B. & S. gauge, which in cities should be painted with waterproof paint or Nubian enamel, as the zinc coating is soon destroyed by the chemical action due to the smoke in the atmosphere. They are run very much in the same manner as the feed wires, about two feet above the trolley lines, and pulled very tight. These guard wires should have circuit breakers in them at regular distances of about one thousand feet or less, which may have a lead wire or jumper around them if the wire is to be used for signaling purposes.

In the case of side pole construction, where the feed wires are run on arms attached to the span poles, the feed wires where they cross the street should be raised above the trolley and guard lines by means of raised arms similar to the one shown in Fig. 3, which is clamped to the pole by means of iron bands and is kept from turning by set screws. The span wires with the hangers attached should now be put in place, after the completion of the feed lines, and the trolley wire run in a similar manner, the only difference being on the curves and joints and in its being hung under the arms or span wires by means of hooks made of heavy steel wire. There is also a great difference in the manner of making splices, which is by the use of splicing ears that are

FIG. 1.—METHOD OF HOLDING LINE PREPARATORY TO MAKING SPLICE.

put in the line after it is pulled up tight, the wire being held temporarily by clamps and turnbuckles, as shown in Fig. 1. These ears should be attached to the arms or span wires in the same manner as the regular supporting ears. The practice of making Western Union or sleeve joints in these lines is, I hope, a relic of the past. After a reasonable amount of wire, say a mile or so, is run out or a curve is reached the wire is drawn up sufficiently tight to allow about eight or nine inches sag in summer and about five inches in winter, depending largely

FIG. 2.—TEMPORARY MANNER OF HOLDING CURVE.

on the size and strength of the wire used, and it is held in place by a head guy clamped to it running to the base of a pole. The turnbuckle at the joint is then drawn up about a foot and the exact location of the splicing ear marked on the wire with chalk or a burnisher, but under no circumstances should it be scratched there with a file. The surplus ends are then cut off with a bolt cutter, which is, by the way, the only thing which will cut trolley and cabled wires and make a good job of it. The splicing ear is then put in position and the wire fastened to it in the regular way according to its kind, when the turnbuckle

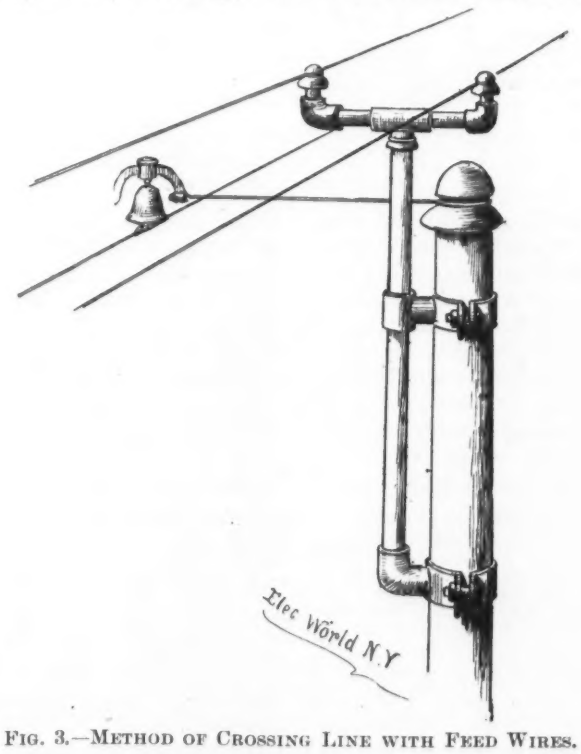


FIG. 3.—METHOD OF CROSSING LINE WITH FEED WIRES.

are slacked off and the clamp removed. Circuit breakers are put into a line in an exactly similar manner.

After the splicing ears and circuit breakers are in place, the section may be fastened to the supporting insulators either by soldered ears or good mechanical clips. If the former are used they should be soldered by means of a copper bolt, and not by either pouring the solder on to them or by the use of blow lamps, the former being weak and the latter injuring the wire. And under all circumstances soldering salts should be used instead of acid or resin. On curves the trolley wire is pulled out over the track by loosely attached temporary pull-off wires running to the poles, their location having been ascertained, as described in the previous article.* Their length is just sufficient to allow the trolley wire to curve about one foot to the inside of the centre of the track, its exact location being determined by the radius of the curve and the nature of the trolley stand, together with the judgment of the constructor. The outside wire is first run, and the inside one pulled from it by a continuation of the pull-off wires.

*See THE ELECTRICAL WORLD, March 21, 1891.

Line switches should be so constructed as to admit of their being moved if necessary, and should be without moving parts. All movable apparatus intended to be operated by the trolleys passing under it and by gravity is liable to become clogged with grease or ice and is as a usual thing either weak or bulky. Where these switches are to be put in, the line is temporarily held by means of clamps and turnbuckles, as is shown in Fig. 2, until after it is pulled up and the curves are in position. Then the switch is put in in very much the same manner as the splicing ears and circuit breakers, enough of the end of the wire being left to allow the switch to be moved should the occasion require.

Before the insulators are placed in position they should be painted with either P. & B. paint or with Bonnell's enamel, which will lessen to a great extent the leakage due to moisture. These insulators should also be of sufficient size to obviate any possibility of an arc being formed by the trolley running off and striking both line wire and hanger. The permanent pull-off for the curves should be made of cable wire and should not be fastened to the ear bodies permanently until the road has been in operation for some time, as they are liable to stretch some one or two inches.

If the trolley runs off at any switch it should be chalked and the car run under it a few times, when it will be seen just where it runs off, and the switch moved forward or backward will remedy the trouble if the switch is properly constructed.

At every tenth pole short pieces of No. 6 B. & S. wire should be run from the feed wires to the trolleys and there fastened by regular feed-ears, and the trolleys should also be cross-connected at short intervals.

Broken or otherwise defective insulators may be found where iron poles are used by a wire leading from the base of the pole to the rail, a flash due to the resistance of the current indicating a ground. Slight ones give a very small shock, but a man standing on the rail holding the wire will receive a very decided shock.

A mixture of black lead and vaseline rubbed on the trolley wire will prevent the clinging of sleet, and will not clog the trolleys unless too thickly applied. Breaks in the line may be temporarily repaired by means of a short section of wire clamped to the trolley and pulled up with a turnbuckle; after which the permanent repairs may be made by splicing in a section of wire with regular splicing ears.

The Magnetic Circuit of Transformers: Closed Versus Open.*

BY S. EVERSHED.

(14) But suppose the transformer is used for house lighting. The spring or autumn load in a house may be taken at about one-third of the lamps wired running six hours a day; with a maximum load of less than 50 per cent. of the lamps wired. So that 10 h. p. will easily provide for 400 lights wired, and its daily output will be roughly 24,000 watt hours. The loss from C^2R may be neglected except during the six hours at $\frac{400}{3} \times 30 = 4{,}000$ watts when the secondary current is 40 ampères, and $C_s^2\, R_s = 15$ watts, and about 16 watts in the primary. The loss in $C_p^2\, R_p$ from the exciting current is about .5 watt. The all-day efficiency on the stated load is given in table V.

TABLE V.—ALL DAY EFFICIENCY OF 10 H. P. TRANSFORMER ON 4,000 WATTS FOR SIX HOURS.

Total output	24,000	watt hours.
24 hours' waste in the core at 400	9,600	"
24 hours' waste $Cp^2\, Rp$ in exciting at .5	12	"
6 hours' waste $Cp^2\, Rp + Cs^2\, Rs$ at 31	185	"
	33,797	

$$\text{Efficiency} = \frac{24}{34} = 71 \text{ per cent.}$$

It is worth remarking that, during the great B. T. *versus* A. T. controversy a few years ago, Mr. Crompton declared that the efficiency of alternate current transformers was no higher than he could get with battery transformers. The champions of the A. T. system did all they could to crush Mr. Crompton, but he stuck to his guns, as his manner is, and after all it seems he was right. If we had chosen a 50 or 100-lighter, such as would commonly be used in a house, the efficiency would have come out nearer 60 than 70 per cent.

(15) It may be objected that such a large transformer as 10 h. p. would not be used in the way we have imagined, but would be placed in a sub-station, where during the day a small transformer would take its place, and so save the inordinate waste in the core. The writer may be permitted to doubt whether a sub-station transformer system will pay. The *raison d'être* of the transformer system lies in its great flexibility and economy in mains, whereby a lot of scattered lighting over a large area can be profitably run from one station. This almost necessarily implies the use of a small transformer to every house, with a larger one occasionally where several adjoining houses require light. But the moment we begin to use the sub-stations where a light load transformer is switched on during the daytime we sacrifice much of the flexibility and increase standing charges for rent and superintendence. In order to

*From *The Electrician* (London); continued from THE ELECTRICAL WORLD of March 21, 1891.

save the coal bill appreciably, we must use a very small day transformer so as to run it at least half load. Take an example. Put on a 1,000 watt transformer for 18 hours, and the 10 h. p. for 6 hours. The small transformer would waste at least 130 watts in its core, or $130 \times 18 = 2{,}300$ watt hours, the 10 h. p. wasting $400 \times 6 = 2{,}400$, and the total daily waste will be 4,700 watt hours as against 9,600, almost exactly half as it happens, so there is a saving of something like 5 B. T. units, and the saving in coal and running expenses might amount to 2d. per unit, or 10d. a day for a sub-station running 400 lights. The saving in a 2,000 light sub-station may be taken at 4s. 2d. a day. The attendant would dispose of at least 3s., leaving 1s. 2d. for rent, interest on secondary mains and sub-station fittings. Truly there is not much margin.

(16) It might be supposed that one attendant could look after four or five sub-stations; but in this favored country, at all events, town districts are liable to sudden fog, and there would be some risk of damage to the small transformer unless the attendant were ubiquitous; remember that it would be overloaded with one-tenth of the lamps on.

Perhaps, however, every central station, like every railway signal box, would have a number of fogmen attached to it. Signalmen often have considerable difficulty in getting their fogmen out in time, and a central station manager would have precisely the same trouble, with the additional one that the sub-stations would be at a very considerable distance from the central station.

Of course, automatic switches might be devised to save the need for an attendant; but automatic switches in the primary circuit are not pleasant to contemplate.

In country districts, where the transformer system is without a rival, sub-stations are out of the question.

(17) In what follows, therefore, we shall assume that the transformer primary will be on continuously, and endeavor to get a higher all-day efficiency by reducing the enormous waste in the core. This can be effected in three ways—(1) the frequency can be diminished, (2) the maximum induction can be reduced, or (3) we can use less iron in the core, in each case increasing the number of turns of the coils to keep the volts up. Now, when we increase the number of turns we either increase the total amount of copper or have a greater drop in E. M. F. over the coils, and we ought to fix on some limit for the latter, as it is as obviously absurd to compare the efficiencies of two transformers having different full-load drops, as it is to compare two shunt dynamos with regard to their regulation. Suppose the maximum loss of volts over the mains was 1 per cent., and allow for one per cent. in the house switches and leads, if the loss over the transformer coils at full load is three per cent., we should have a total drop of five per cent. with every light on; but as the maximum only amounts to about eighty per cent. of the transformer's full load, the actual drop on the lamps would not exceed four per cent., and that very rarely. A large variation in E. M. F. is occasionally deprecated on the score of damage to or inefficiency of lamps, but as a rule lamps are not overrun at the highest E. M. F., and a large drop merely lengthens their lives. It also tends to grumbling on the part of the consumer, and this last factor practically determines the maximum allowable loss of E. M. F.

In addition to the three methods already mentioned, an ingenious scheme for raising the commercial efficiency of

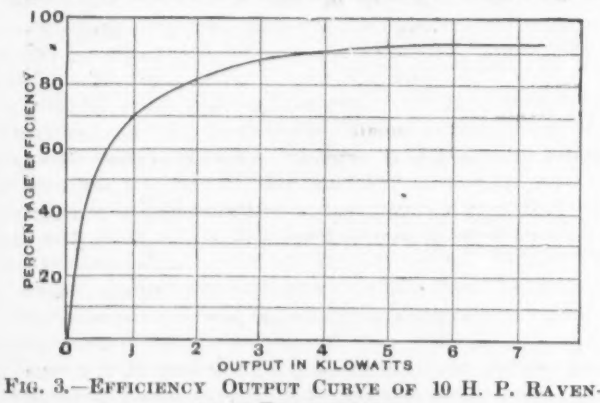


FIG. 3.—EFFICIENCY OUTPUT CURVE OF 10 H. P. RAVENSHAW TRANSFORMER.

transformers on any load whatever to something like 100 per cent. ought to be alluded to here. Like most really ingenious novelties, it hails from America. According to this invention, the house-meter is put on the primary mains, so transferring the whole of the loss to the unhappy consumer. This arrangement certainly has great charms—for the supply company. The less efficient the better they like it.

(18) Taking three per cent. as the limiting loss in E. M. F., let us begin by lowering the frequency in the 10 h. p. transformer from 70 to 35 volts per second, without making any change in the core. The coils now require twice as many turns, and as we cannot interlink a greater *section* of copper with the core, we must use wires and strip of less than half the section in each case. It would be exactly half were it not that the space required for insulation is doubled. The resistance of each coil will now be at least five times as great as those given in Table III., so that the maximum drop will be $1.4 \times 5 = 7$ per cent. If the second plan were carried out we should come to exactly the same conclusion, for to get the same E. M. F. with half the induction would require twice the turns, and the coils would have a full load drop of seven per cent.

(19) Clearly, neither a lower frequency nor a lower induction is any good unless the size of the core is altered. Keeping the core area the same, increase the mean length of the magnetic circuit by 30 per cent. We may take the core to be a square link, and shall find we have increased the area for coils by 110 per cent. Double the number of turns of 10 per cent. greater section than the original wires and strip will make the resistances practically twice as great (the mean length per turn having been increased by 10 per cent.), and the drop will be 2.8 per cent., just under the limit. But the volume of iron is now 30 per cent. greater. Putting this modification on the same load as the

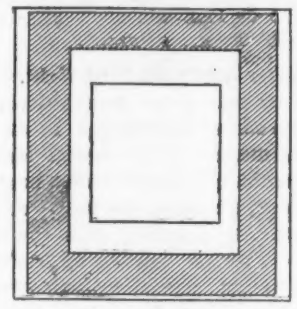


FIG. 4.—PLAN OF CORE OF 10 H. P. RAVENSHAW TRANSFORMER, SHOWING PORTION USED IN NO. 3 SHADED.

original transformer, we can write down the losses at once. They are given in table VI.

TABLE VI.—MODIFIED 10 HORSE-POWER TRANSFORMER, NO. C.1.
Maximum $\mathbf{B} = 10{,}000$; $F = 35$.
Load as in Table V.

Total output	24,000	watt hours
24 hours waste in core at 278	5,500	"
24 ditto waste in exciting at 1	24	"
6 ditto $C_p^2 R_p + C_s^2 R_s$ at 62	372	"
	29,896	

$$\text{Efficiency} = \frac{20}{31} = 80 \text{ per cent.}$$

Full load drop = 2.8 "

A distinct improvement has been made, but at the cost of an increase of 140 per cent. in the weight of copper, 30 per cent. in iron, and perhaps 50 per cent. increase in labor. Whether a gain of nine per cent. is worth the price is doubtful.

(20) A better result can be got for the same outlay in materials and labor by the second plan, namely, keeping the frequency at 70, and reducing the maximum $\mathbf{B}$ to 5,000 gausses. The hysteresis loss at 5,000 gausses is almost exactly one-third of the loss at 10,000, the results obtained by Mr. Vignoles and the present writer agreeing precisely in this respect with those published by Professor Ewing. The eddy current loss at half the induction is of course quartered. The coils and size of core will be exactly the same as in table VI. The efficiency of this modification is shown in table VII.

TABLE VII.—MODIFIED TEN HORSE-POWER TRANSFORMER, NO. C.2.
Maximum $\mathbf{B} = 5{,}000$; $F = 70$.
Load as in Table V.

Total output	24,000	watt hours.
24 hours' waste in core at 163	3,900	"
24 hours' waste in exciting at .6	12	"
6 hours' waste $C_p^2 R_p + C_s^2 R_s$ at 62	372	"
	28,284	"

$$\text{Efficiency} = \frac{24}{28} = 85 \text{ per cent.}$$

Full load drop = 2.8 per cent.

Here is an apparent gain of 14 per cent. in efficiency; but it must not be forgotten that the drop in the original transformer was only 1.4 per cent., and in order to compare it with those given in tables VI. and VII. it ought to be rewound to have the same full load drop.

In fact, the coils must be wound with wires and strip of half the section, the turns being left unchanged at 1,120 and 56 as given in table III. The new coils occupying approximately half the space, the mean length of the magnetic circuit can be reduced by 20 per cent. The efficiency of the arrangement is given in table VIII.

TABLE VIII.—MODIFIED TEN HORSE-POWER TRANSFORMER.
Maximum $\mathbf{B} = 10{,}000$; $F = 70$.
Load as in Table V.

Total output	24,000	watt hours.
24 hours' waste in core at 330	7,900	"
24 hours' waste in exciting at 1	24	"
6 hours waste $C_p^2 R_p + C_s^2 R_s$ at 62	372	"
	32,296	"

$$\text{Efficiency} = \frac{24}{32} = 74 \text{ per cent.}$$

Full load drop = 2.8 per cent.

When we consider that this last transformer requires only two-thirds the quantity of iron and one-quarter of the copper taken by those in VI. and VII., we can have no doubt which would be chosen by a supply company.

(21) So far the rise in temperature of these various modifications has not been considered. The reason for this apparent neglect is very simple. When we limit the maximum loss of volts at full load to three per cent., it is almost impossible to design a transformer below a safe limit. In this respect the transformer having insufficient radiating surface to keep its temperature in table VIII. is very much worse than any of the other modifications; yet although it would acquire undesirably high temperature if left on continuously at full load, its maximum temperature on the time load we have assumed would not exceed 30 degrees C. above that of the surrounding air, say an actual temperature of 50 degrees C. Probably no one but a financier would care to run a transformer with so small a margin, and we shall therefore put it out of competition. To complete the set of closed transformers, we still require one having the maximum $\mathbf{B} = 10{,}000$ and $F = 70$ with a full load drop under 3 per cent.; and the simplest modification of the original transformer by which these conditions can be fulfilled is obtained by reducing the sectional area of the core, and increasing the number of turns on the coils in proportion.

(22) Suppose core plates of half the width of those in the original transformer are built up into a core of the same depth, so as to get half the sectional area, and made into a rectangular link inclosing twice the area for coil space. This alteration is shown in Fig. 4, which is a plan of the original core, the shaded portion being the new core. The coil space is not quite doubled, but the length of an average turn being now seven per cent. less, the section of the wires and strip may be reduced in proportion, so that exactly twice as many turns can be wound on, thus doubling the resistance of each coil. The volume of iron in the core is not quite half 6,600 cubic metres; it is actually 3,560 cubic metres. The sectional area is 29 square centimetres, and the average length of the magnetic circuit 122 centimetres. The all-day efficiency of this transformer is given in table IX.

TABLE IX.—MODIFIED 10 HORSE-POWER TRANSFORMER NO. C.3.
Maximum $\mathbf{B} = 10{,}000$; $F = 70$.
Load as in Table V.

Total output	24,000	watt hours.
24 hours' waste in core at 218	5,200	"
24 hours' waste exciting at .5	12	"
6 hours' waste $Cp^2 Rp + Cs^2 Rs$ at 62	372	"
	29,584	"

$$\text{Efficiency} = \frac{24}{29.6} = 81 \text{ per cent.}$$

Full load drop = 2.8 per cent.

Thus, of the three proposals for raising the efficiency, the second is the best; but No. C.2 is only four per cent. better than No. C.3, and the latter uses considerably less material. We shall return to the question of raising the efficiency by lowering the induction after we have investigated the properties of open-circuit transformers.

(23) It will be noticed, that although the C^2R loss due to the exciting current is absolutely negligible in every case we have so far discussed, yet it has been inserted in all the efficiency tables. This was purposely done in order to draw attention to the enormous disparity between the two constant losses, viz., waste in the core and waste in the coils. Such a disparity might suggest that if we could reduce the core waste at the expense of the coil waste we should get greater all day efficiency; and in fact that is precisely what is done in an open transformer, with what results we shall now show.

We will first convert No. C.3 into an open transformer. Take the two portions of the core *A A* (Fig. 5), and, without removing the coils, place them in one line, so as to form a transformer of Ruhmkorff coil fashion, the arrangement being shown in Fig. 6. The total length of the core is now 76 centimetres, and of the coil 56, leaving 10 centimetres of core projecting outside the coil at each end. The total volume of iron used is only 2,230 cubic centimetres, and if we were still able to ignore the waste due to the exciting current we should be certain of obtaining a higher efficiency. But the exciting current will obviously be very

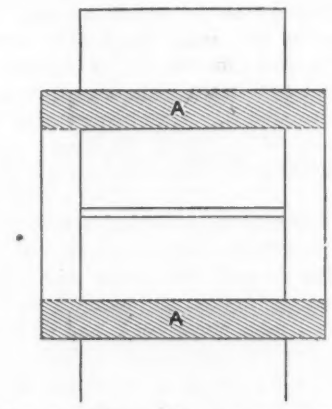


FIG. 5.—CLOSED TRANSFORMER NO. 3.

large, and it becomes necessary to ascertain approximately what its value will be. This involves a calculation of what we are told ought not to be called the magnetic resistance of the air path from pole to pole. Imagine a long and very thin bar magnet has a sphere of iron fixed at each end, and assume that the whole of the induction through the magnet passes into the air at the surface of each sphere and so radially into space. In short, assume the old polar theory, only look at it from a modern point of view. It is clear that the magnetic resistance of an elementary spherical shell of air concentric with one of the magnet poles is $\frac{dr}{4\pi r^2}$, r being the radius of the shell. The resistance from the surface of the iron sphere to infinity will be

$$\int_a^\infty \frac{dr}{4\pi r^2} = \frac{1}{4\pi a},$$ where a is the radius of the iron sphere.

The resistance from infinity back to the other pole being of course an equal amount, the resistance from pole to pole is $\frac{1}{2\pi a}$

(24) So much for the imaginary magnet. When we try to apply the same theory to our open transformer we find, in the first place, that it has no convenient iron sphere fixed on each end of the core; but a little consideration shows that nearly all the resistance is in the first few centimetres of air surrounding the pole, and that it makes little difference in the result whether we start from a sphere or a cylinder, or a cube, provided they expose the same surface so that the induction density is as low as possible. The surface on each projecting end of the core in Fig. 6 is 313 square centimetres, and a sphere of this surface would have a radius of five centimetres, so we will suppose spheres of this radius have replaced the actual ends. The next difficulty lies in the fact that a considerable portion of the whole induction passing from pole to pole passes backwards through the coils, so that it will be safe to integrate over only three-fourths of the whole surface of the spherical poles, so as to include only that induction which threads both coils once. This limit, beyond which the induction is left out of account, is indicated in Fig. 6 by the dotted lines, *L*, *L*. Finally, then, we get $M\,R = \frac{4}{3}\,\frac{1}{2\pi a} = \frac{4}{30\,\pi}$, or $\frac{4}{90}$ roughly.

(25) The same maximum **H** required for the air path is then $\frac{4}{90}\,\mathbf{B}\,A$, A being the area of the core = 29 centimetres; so that **H** = 12,900 for the air, and $6 \times 76 = 460$ nearly in the iron, a total **H** = 13,400 nearly enough, which, divided by 1.26 N_p, gives us the exciting current maximum, namely, 4.8 ampères, which is equivalent to an effective current of 3.4 ampères. In fact, the exciting current is nearly as large as the useful current at full load. However, bad as it looks, let the transformer be tried on the same load as the others, for it must not be supposed that this large exciting current implies large waste of power in the transformer; the primary E. M. F. wave, and the exciting current, differ in phase by very nearly a quarter of a period, so that practically the only loss is from C^2R. There is sometimes a confusion of ideas in calculating the

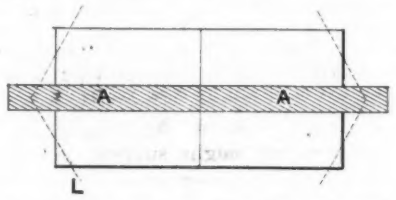


FIG. 6.—NO. 3 AS AN OPEN TRANSFORMER.

C^2R loss due to two alternating currents differing in phase. The true loss is

$$\frac{R}{T}\int_0^T \left(C_1 + C_2\right)^2 dt, \text{ that is to say,}$$

$$\frac{R}{T}\left\{\int_0^T C_1^2 dt + \int_0^T C^2 dt + 2\int_0^T C_1 C_2 dt\right\}$$

and, as is well understood, the integral of the last term is nothing when C_1 and C_2 differ by exactly one-quarter of a period, so that we can, in the case under consideration, safely take the C^2R loss from the exciting current quite separately from that due to the useful current.

(26) The dimensions and other particulars of the open transformer are collected in table X., from which we can determine the efficiency on the usual load. This is worked out in table XI.

TABLE X.—10 HORSE-POWER OPEN TRANSFORMER (NO. O.3).

Full load output	=	22.4	kilowatts
Frequency = F	=	70	
Total volume of iron in core	=	2,230	c. c.
Sectional area of iron in core	=	29	sq. cms.
Mean length of iron in core	=	76	cms.
Width of core plates	=	5.1	cms.
Thickness of core plates	=	.048	cms.

	Primary.	Secondary.
Volts	2,000	100
Turns on coil	2,240	112
Resistance	7.6	.0188

TABLE XI.—TEN HORSE POWER OPEN TRANSFORMER (NO. O.3).

Maximum **B** = 10,000; F = 70.

Load as in Table V.

Total output	24,000 watt hours.
24 hours' waste in core at 137	3,280 "
24 hours' waste in C^2R at (7.6×3.4^2)	2,110 "
6 hours' waste in $C_p{}^2 R + C_s{}^2 R_s$ at 62	372 "
	29,762

$$\text{Efficiency} = \frac{24}{29.8} = 81 \text{ per cent. (nearly enough).}$$

Full load drop = 2.8 per cent.

Astounding as it may seem, the removal of about one-third of the core and rearrangement of the coils and remainder of the core as an old-fashioned induction coil has made practically no difference whatever in the efficiency. But although considered merely by itself, this transformer is in every way as efficient and would be somewhat cheaper to build than the closed transformer from which it has been formed. The large exciting current required is sufficient to condemn it when we recollect that a transformer is only one item in a system of distribution, for in a central station running transformers like No. O.1, although the light load during the day would be small in *power*, yet large machines must be kept running at practically no load simply to provide the enormous exciting current, so that the efficiency of the generating plant would be very seriously reduced.

(To be continued.)

Transformer Distribution.*

BY J. SWINBURNE.

Take the case of a machine like the Siemens, with coils passing between poles. If there is a continuous current in the armature in some positions it will assist the field magnets, and in others it will to some extent weaken them, while in intermediate positions it has no effect on the magnets as a whole. In an alternate-current machine, though the armature current is alternating, relatively to the field magnets, it is direct. If a series of instantaneous photographs of the armature current

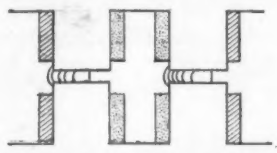


FIG. 3.—DIAGRAM OF FIELD MAGNET POLES.

could be taken, each part of the air space would have its direct current.

Fig. 3 is a diagram of the field-magnet poles of a machine. There are supposed, for simplicity, to be twice as many pairs of poles as there are armature coils. If one side of a coil is between each pair of poles, if there were no armature current, the fields would be inducing a maximum pressure. If the pressure curve of such a machine were traced, and placed in the diagram of the poles, it would be as shown in Fig. 4. The positive direction of the current or pressure in the armature and field-magnet coils is shown

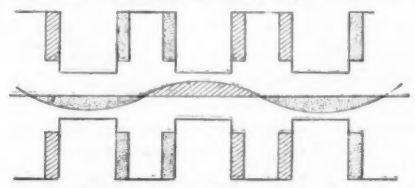


FIG. 4.—PRESSURE CURVE WITH DIAGRAM OF POLES.

by shading, the negative by dotting. If electricity flows in the armature when the sides of the coils are in the active fields, one side of the field between the poles is strengthened and the other weakened, as shown in Fig. 2. This action is fully explained in the case of direct currents in my paper already referred to; but in alternate machines the action is much more complicated, for there is no longer a continuous succession of conductors each carrying the same current as it passes any given position. If the pole-pieces were laminated, the distribution of field would vary as each conductor passed; but as they are not laminated, Foucault

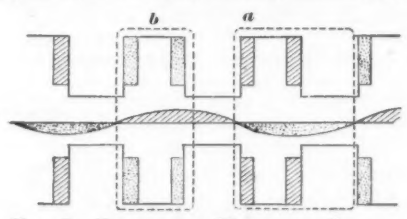


FIG. 5.—DISPLACED PRESSURE CURVE.

currents developed in the pole-pieces tend to check variations under influences varying from 200 to 600 per second. The field thus becomes stronger on one side. The curve of pressure thus gets displaced, as shown in Fig. 5.

If the external resistance is non-inductive, this may be regarded as a current curve. It will be seen that each magnet is now exposed to the back induction due to the armature current. A circuit *a* taken round the field-magnet circuit is interlinked with the whole wave. The line integral is not changed if it is taken round any other circuit, so that the sides are the same distances apart as they are in *a*. A circuit taken as shown at *b*, however, includes only

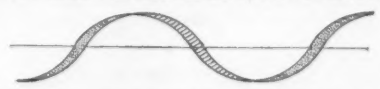


FIG. 6.—TWO PRESSURE CURVES SLIGHTLY OUT OF STEP.

half a wave; so that from Fig. 5 both the cross and the back induction could be completely worked out. In most machines it is impossible to make such a diagram accurately; but in others, such as drum armatures, with poles and coils of given widths, it is not so complicated.

The effect of the armature current, then, is first to make the current lag relatively to the position of the field magnets, and then to lessen the pressure as a whole. It thus resembles the effect of the insertion of artificial self-induction.

I think to call this "self-induction," and to assume the harmonic law just to make calculation easy, is disguising the real nature of the action, and may lead to very serious errors. The armature reaction theory is also infinitely easier to understand, and to follow in one's head. The result of it is, in short, that if the current lags the field is weakened; if it leads, the field is strengthened. If the current is in the direction agreeing with the electromotive force of the machine, it tends to lag, owing to cross induction; if it is against the electromotive force of the machine, as in the case of a motor, it tends to cross-magnetize the fields in the opposite direction.

We may now examine the question of parallel running from the armature reaction point of view. Though it may be out of its proper place in the paper, the question of motors may be to some extent discussed at the same time.

Suppose, as in the first place, a pair of terminals in connection with a station, so that the electromotive force on them is independent of any current, or of the machine under discussion connected to them. It is necessary to keep clear, for the moment, of any ideas connected with *L*. The armature circuit must be regarded as devoid of self-induction.

A machine without friction may be imagined, and when its field magnets are separately excited, so as to give an electromotive force exactly equal to that of the mains when it is to be connected so as to be in step, it runs as a motor taking no current. At each instant the electromotive force of the machine is exactly equal to the electromotive force of the mains, so no current passes. On putting on some load the machine begins to lag. As soon as the machine lags, a current passes through the armature. The current due to the difference of two equal alternating electromotive forces is not in step with either of them. This is shown in Fig. 6, where two pressure curves are drawn a little out of step. The current through resistance is proportional to the shaded parts. If the electromotive force of the machine were still the same as that of the mains, it would still develop no power as a motor, because at some parts of the period it would be supplying power to the mains, and at other parts the mains would be supplying power to the armature; for at any instant the armature current would be equal to the difference of the two electromotive forces divided by the resistance of the armature. The average current curve is shown in Fig. 7. The electromotive force of the machine does not, however, remain equal to the main electromotive force, merely differing from it in phase, but is decreased by the reaction of the armature current on the field magnets. The average current curve shows that there would be considerable back induction, or many ampère turns tending to weaken the field. This weakening of the field by the armature reaction allows the main also to supply a current against the electromotive force of the machine, so that it acts as a motor, and power

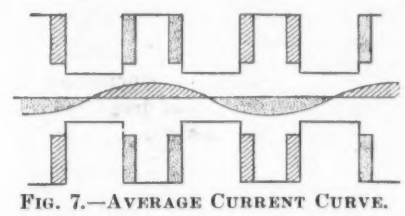


FIG. 7.—AVERAGE CURRENT CURVE.

can be taken from it. If the load is altered the machine will increase or decrease its lag, so that its effective field is reduced to just the right value to allow the machine to absorb electrically the power taken from it mechanically. As lag is necessary in order to weaken the effective field, so the current in the armature is no longer in step with the electromotive force of the mains. The result of this is that it is not at the maximum value at the same instants as the electromotive force is; so that the power taken by the motor is less than the product of the effective electromotive force of the mains and the effective current of the machine. The electromotive force and current may be so much out of step that the power of the motor is small, though the armature current is large. The availability of the machine as a motor thus depends on the resistance of the armature, and on its reaction on the field. For instance, if the machine has very little armature resistance, a very small reduction of its electromotive force will allow a large armature current to pass. If, on the other hand, the armature resistance is high, the armature must have a large reaction on the field so as to reduce the effective electromotive force. If, at the same time as the load is put on, the field of the motor is artificially weakened by reducing the excitation—for instance, by the insertion of resistance in the field circuit—the electromotive force of the machine may be reduced enough to allow current from the mains to act in step with the main electromotive force. For instance, if the supply circuit is of 2,000 volts, and if an ordinary separately excited 2,000-volt machine is connected, and excited so as to give 2,000 volts with the same frequency, and if this machine is loaded as a motor with 40,000 watts, or 54 h. p., it will lag until the field is weakened enough to let current enough pass to give the power. This current will be more than 20 ampères. But if the machine as a dynamo can give 20 ampères with the loss of 100 volts in the armature, due to the resistance, and if the machine is excited so as to give 1,900 volts on open circuit at the normal speed, and is then thrown into the circuit at an instant when it is in step, and a load of 38,000 watts, or 51 h. p., taken out, it will remain in step; for the electromotive force of the machine is always just enough below the main electromotive force to allow the right current to pass. The effective current is then 20 ampères. The main circuit thus supplies 2,000 volts and 20 ampères; 2,000 watts are lost in overcoming the resistance of the armature, and 38,000 are available at the pulley. The losses by friction and Foucault currents are here neglected for the sake of simplicity. In practice a little less than 51 h. p. would be obtained for external use. If the field has not been weakened by reducing the excitation, the effective current—that is to say, the root of the mean square of the current, or the current as measured by an electro-

* A paper read before the Institution of Electrical Engineers, London; continued from THE ELECTRICAL WORLD of March 21, 1891.

dynamometer—would be more than 20 ampères, so that there would be extra loss of power in the armature.

If the machine is to be worked as a generator in parallel with the main circuit—that is to say, if it is to supply power to the mains instead of to take it from them—the same reasoning holds good. If the machine is excited so as to give 2,000 volts at no load, and is thrown into circuit at an instant when it is in step—if the engine supplies just enough power to overcome friction, there will be no armature current, as the electromotive force of the machine will, at every instant of the period, be exactly equal and opposite to that of the mains. If the engine supplies just a little too much power, the machine will begin to lead, and an armature current will pass, which will strengthen the fields by reaction, and the machine will at some instant act as a generator, because its electromotive force is now a little higher, as the armature current has strengthened its field. Similarly, if the steam of the engine were completely shut of, the machine would lag until it worked as a motor. If now the steam is turned on until the dynamo supplies 40,000 watts to the mains, the machine will increase its lead until the armature current strengthens the field enough to give the full output. The armature current must be out of step with the electromotive force of the machine.

In these examples back induction has alone been considered; but the effect of cross induction must also be taken into account. Cross induction, in the case when the machine is working as a dynamo, makes the current lag. This weakens the field and counterbalances to some extent the effect of the leading current due to the pressures being out of step. A still greater lead is therefore necessary to make the machine work as a dynamo. Suppose, however, that the field excitation is strengthened to balance this back induction as well as the loss by armature resistance—that is to say, suppose it is excited to give 2,000 volts and 20 ampères on resistance, in spite of the armature reactions—it will run in step on the mains.

It is thus possible by altering the field excitation of such dynamos to make them work well as generators or motors on supply circuits. Instead of depending on the reaction of the armature to strengthen or weaken the field, the field excitation may be automatically regulated, so that the current and electromotive force of the machine are always in step, or very nearly so.

Take first the case of a separately excited motor. The field magnets may have an additional set of coils, and these are put in series with the main armature current, which is redressed or rectified by a commutator. These coils are arranged so as to demagnetize or weaken the field as the current increases, so that it is not necessary for the machine to lag in order to take a large load.

The machine may be made to excite itself. In that case, special exciting coils on the main armature are provided. These are connected with the circuit for exciting the field magnet. If a machine made in this way is used as a motor without a series demagnetizing circuit round the field magnets, it begins to lag as soon as load is put on, and the armature current then reacts on the fields and weakens them. As the exciting coils now pass through the same field, this will also lessen the field excitation directly; and as soon as the field is weakened by the armature reaction, the ampère-turns round are also reduced, because the electromotive force in the exciting circuit is lessened. A very small lag will thus weaken the field considerably, so that a large load may be put on without the lag being great enough to make the machine inefficient. A series demagnetizing circuit may be used in addition If the ampère-turns of the field magnet are not adjusted to the load with perfect accuracy, the machine adjusts it If by lagging or leading very slightly.

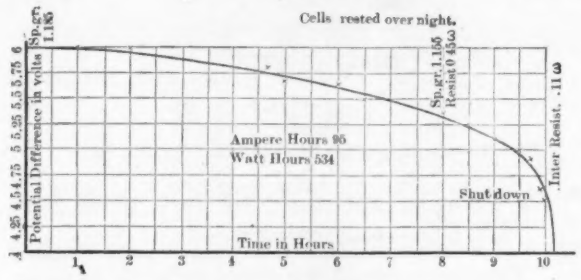
Machines with fields excited chiefly by special exciting circuits on the main armatures, and partly by series circuits, may be specially useful for working in parallel as generators. The series circuits are then arranged to magnetize instead of demagnetize. If power is applied to a motor instead of taken from it, it becomes a generator, and the direction of its main current is reversed, both in the armature and the series coils on the fields; so that a motor with a backward series circuit becomes a generator with a forward series circuit. If one machine when used as a generator begins to lead because too much power is supplied to it by its engine, its field is strengthened by the series circuits, and this increases the armature electromotive force enough to make it give a large output corresponding to the power supplied to it. If machines excited from special armature circuits, without series circuits, are run in parallel, they will keep in step, because the least leading or lagging alters the field excitation.

(To be continued.)

The Cambridge Accumulator.

Mr. George E. Hatch, of Boston, Mass., has recently invented a most commercially and theoretically efficient form of secondary battery cell. In this accumulator an especially prepared porous earthenware plate takes the place of the leaden grids as the support of the active material, and a thin sheet of lead or other suitable conductor is placed between the porous plates and in contact with the active material which is contained in grooves running horizontally across the porous plates.

In this way the weight of the cell is reduced to the minimum weight of the active material and its porous support and the necessary electrodes, which may be of very light weight. The electrodes are made of an alloy which is only slightly subject to electrolytic action, thus securing their durability; and when they require to be exchanged the replacing of them is very easily and inexpensively accomplished. The element, consisting of the set of porous plates carrying the active material and alternate electrodes, is firmly bound together with flexible rubber bands which allow for the expansion and contraction of the active material during charge and discharge; and it will be noted that the possibility of short circuiting within the cell, either by buckling or by the disintegration and displacement of the active material or in any other manner, is avoided.



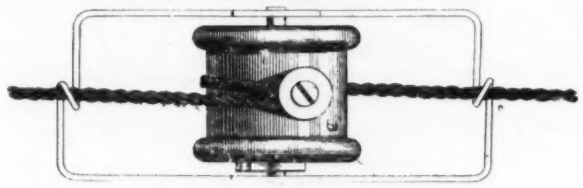
DISCHARGE CURVE OF THE CAMBRIDGE ACCUMULATOR.

The earthenware plates are made of a special preparation of clay and are extremely porous and light, as will be evident from the fact that a 7-inch square plate ¼ inch in thickness absorbs and retains 5 ounces of electrolyte, and the porous plates in a single cell of 150 ampère hours capacity absorb and contain within themselves ⅝ of a gallon of electrolyte.

The accompanying cut shows the curve of a test of three Cambridge cells recently carried out by Mr. Hatch. It shows the discharge during 10 hours with a starting potential of six volts. At the point where the battery rested over night the resistance is indicated as .045 of an ohm.

The Newton Lamp Extension Device.

The accompanying illustration shows a new extension device for incandescent lamp cords. As can be readily seen, it is of the simplest possible construction and yet a most efficient apparatus. Unlike most devices of the kind, the "Newton" holder can be detached from the cord at will, all that is necessary being to loosen the screw on the side of the small roller. The principle employed is that of the well-known "Hartshorn" shade roller, and the height of the lamp is regulated as readily as that of a window blind. The device is the invention of Samuel O. Newton and Melville A. Newton, of North Pitcher, N. Y.



LAMP EXTENSION ARRANGEMENT.

Wirt Pressure Indicator.

This instrument is the result of a series of tests and experiments carried on by the Electrical Supply Company, of Chicago, with the object of producing a pressure indicator that should be more reliable and accurate than the usual commercial instrument of this kind. The indicator has a case of cast iron with glass front and cast brass rim, moisture, oil, grease and dust being thus guarded against. The principle of action is that of magnetic attraction with gravity control. The design and construction is such that retention of magnetization is practically eliminated, and there is nothing whatever about the instrument which will permit of a gradual variation from truth, such as often happens with instruments employing the heating effect, variation of resistance or permanent magnetism as the controlling force. The resistance of the indicator is principally made up of a new alloy, the feature of which is a remarkably small temperature variation—so small indeed as to be almost inappreciable—and its coefficient shows great constancy. The resistance of the instrument is sufficiently high to be used on iron pressure wires without making allowance for variation, except in the case of unusually long wires. The scale is direct reading, and by the arrangement of a movable index the deflection can be read at a distance of 20 feet, and a deviation of one-half to one per cent. easily perceived.

WIRT PRESSURE INDICATOR.

No gears, springs, multiplying devices, hot wires, or pulleys are used in this indicator, and there is but a single moving part—a cylindrical iron needle, .005 inch thick, and of a shape making it stiff and free from distortion. This and the attached pointer of aluminium are pivoted in the same manner as the main spindles of a first-class chronometer. So confident is the Electrical Supply Company of the reliability of this instrument that the directions sent with it contain the following: "Let it alone. If any one tells you the indicator fails to agree with his idea of what is correct, send to Johns Hopkins, Cornell or Michigan State University for comparison, *at our expense, if found two per cent. wrong and seals unbroken.*"

New Classification of the Electrical Section of the World's Fair.

Our readers will be interested in the fact that the Exposition classification, so far as the electrical department is concerned, has been overhauled and entirely recast. When the general classification was adopted by the Commission, several months ago, the power to make any needed changes in it was vested in the director-general, who has exercised that power by approving and adopting an entirely new classification of the electrical department, elaborated and submitted by its chief, Prof. Barrett. In a few days 3,000 copies of the new classification will be printed and forwarded to all the prominent electricians in the country.

The reasons for reforming this classification were numerous. Prof. Barrett, in his formal request to Director-General Davis for this change, compliments the original classification, considered from a scientific point of view, but represented that for practical purposes it would never do. For instance, it creates a class of "Magnetic Electricity;" but electricians agree that this title is now obsolete, and that what is meant by it is properly described as "permanent and temporary magnets," and a change has been made accordingly. Again, there are many applications of electricity which have no place in an electrical exhibit. For instance, the original classification contains a class of "Electric Forging." But there is, so far as Prof. Barrett knows, no such thing as electric forging. An electric motor is sometimes the driving power in forging operations; but a windmill or a water wheel would answer the same purpose. On the other hand, long-distance telephony, which is a distinct class of telephony, was entirely omitted in the original classification. It also omitted a class for electro-medical exhibits, such as those for the diagnosis of disease, though these instruments have now become a very prominent class. Prof. Barrett has also created a new group, consisting of Patent Office models, in this and other countries, and is already far advanced in his efforts to make this exhibit a brilliant one. Congressman Durborow, the representative of the electrical fraternity in Congress, has been asked to consult with the patent officials at Washington, and a way will shortly be found for reaching those of Europe. The electrical department is the first to secure a change in its classification, but it is said that it will not be the last, and that several other departments will ask for similar changes before long. The following is the new electrical department classification:

DEPARTMENT J—ELECTRICITY.

Group 119.—Apparatus to illustrate the phenomena and laws of electricity and magnetism—Class 718, statical electricity; 719, thermo electricity; 720, magnets, temporary and permanent; 721, induction coils, converters, etc.

Group 120.—Apparatus for electrical measurements—Class 722, standard resistance coils; 723, standard condensers; 724, standard batteries; 725, instruments of precision, voltmeters, ammeters, wattmeters, etc.

Group 121.—Electric batteries, primary and secondary.

Group 122.—Machines and appliances for producing electrical currents by mechanical power—dynamical electricity—Class 726, dynamos of direct, constant E. M. F., varying current; 727, dynamos of direct constant current and varying E. M. F.; 728, dynamos of alternating current, constant E. M. F. and varying current; 729, dynamos of alternating constant current and varying E. M. F.

Group 123.—Commercial transmission and regulation of the electrical current—Class 730, cables, wires and insulation; rheostats, switches, indicators, registering meters, ammeters, voltmeters; 731, safety and protective appliances, lightning rods, lightning arresters, insulators, fusible cut-outs, safety switches, etc.; 732, conduits, interior and underground.

Group 124.—Electric motors—Class 733, direct constant current; 734, direct constant E. M. F.; 735, alternating current.

Group 124 "A."—Application of electric motors—Class 736, street, underground, mining and other railways; 737, elevators, pumps, printing presses and general machinery; 738, toys, novelties and domestic appliances.

Group 125.—Lighting by electricity—Class 739, the arc systems, their lamps, fixtures and appliances.

Group 125 "A."—Heating by electricity—Class 741, for warming and heating apartments; 742, for heating flat irons, soldering irons and other objects used in industrial operations; 743, maintenance of constant high temperature in ovens; 744, electric furnaces.

Group 126.—Electric metallurgy and electric chemistry—Class 745, electrotyping; 746, electroplating, gilding and nickeling; 747, electro deposition of iron and other metals; 748, electrolytic separation of metals from their ores or alloys.

Group 127.—Electric welding, stamping, tempering, brazing, etc.—Class 749 "A," apparatus for and methods of welding or joining iron, steel and other metals; 749 "B," brazing, stamping, tempering, etc.

Group 128.—Electric telegraph and electric signals—Class 750, various systems of transmitting and receiving;

751, chronographs; 752, annunciators; 753, thermostats; 754, fire-alarm apparatus; 755, police telegraph and burglar-alarm apparatus; 756, railroad signal apparatus.

Group 129.—The telephone and its appliances—Class 757 "A," cables, construction and underground works; 775 "B," special protective devices; 757 "C," switchboards; 757 "D," transmitting apparatus; 757 "E," receiving apparatus; 757 "F," signaling apparatus; 757 "G," long-distance systems; 757 "H," various systems of operation; 757 "I," subscribers' apparatus, numbers, code, registers, etc.

Group 130.—The phonograph—Class 758, receiving and recording apparatus; 759, apparatus for the reproduction of recorded sounds and articulate speech.

Group 131.—Electricity in surgery and therapeutics—Class 760, cautery apparatus; 761, apparatus for the application of the electrical current as a remedial agent; 772, apparatus for the destruction of life.

Group 132.—Applications of electricity in various ways not before specified—Class 764, ignition of explosives, gas lighting, etc.; 765, control of heating apparatus by electricity, as applied to steam and hot air pipes and registers; 766, electric pens; 767, application in photography.

Group 133.—History and statistics of electrical invention—Class 768 "A," objects of illustrating the development of the knowledge of electricity and of the application of electricity in the arts; 768 "B," collections of books and publications upon electricity and its applications.

Group 134.—Progress and development in electrical science and construction, as illustrated by patent models of various countries—Class 769 "A," United States Patent Office exhibit of electrical models; 769 "B," Foreign Patent Office exhibits of electrical models.

Col. Louis H. Ayme, at present connected with the *Inter-Ocean*, has been appointed to the position of foreign exchange editor in Major Handy's department of publicity and promotion; and M. Robinson Sallard, correspondent in this country of *La France*, of Paris, has been engaged for service in the foreign work of the department. Both of these gentlemen are accomplished linguists, and admirably fitted to discharge the rapidly enlarging duties of these positions. Colonel Ayme has resided in South America, and M. Sallard was the secretary of Director Jeffrey at the Paris Exposition of 1889.

An Electrical Arcadia.*

BY E. H. JOHNSON.

The chief consideration of those who would build or remodel a city should be not only to provide quick and cheap local transit, but to insist even more strenuously upon cleanliness and atmospheric purity.

The dominant complaint of the metropolitan citizen of the day is of the defective provisions in these respects. The detective senses indicate with accuracy dangerous and unhealthy conditions. Correct the conditions which offend them and city life partakes of the nature and characteristics of life in the open country.

If a deep-seated evil exists, no mere temporizing will suffice to uproot it; radical measures must be resorted to. It is useless, in illustration, to attempt to render artistic an elevated railway structure or a telegraph pole, and equally abortive to attempt the conversion of the horse car into a chariot alike pleasing to the eye and the nose. It is a waste of inventive calibre to undertake the perfect combustion of illuminating gas and its collateral products. It is likewise beyond the vigilance of municipal authority to so regulate kitchen garbage and refuse as to despoil it of its death-dealing potency. Nor is it yet within the power of the authorities to so surround the fires of the factory and the home as to eliminate therefrom the element of danger to life and property, or to effect the amelioration of that exasperating compound, the draught horse and the cobblestone.

The object of this contribution is to emphasize the folly of all this waste of time and money in futile attempts to patch and repair. At the same time it is recognized that to pull down when you are not ready to build up is even a worse folly. Therefore, starting from the premises that present agencies are of irredeemable character, we must needs indicate that future agent which is at present available and show how it may be made to fill all the offices we have vacated without itself offending in a like manner. Upon this understanding we will now proceed to pull down the poles and the elevated structures, uproot the gas and steam pipes, rip up the street tracks and granite abominations, send the car and the draught horse to the farm, and generally carrying the war into our domicilian Africa, proceed to exterminate that hydra-headed devil, the heating and cooking apparatus, casting out of our cellars engines, furnaces, ranges, gas and oil stoves, sweeping out our chimneys and generally eliminating all traces of these domestic dragons, and then, if for no other than æsthetic and sentimental considerations, continue the renovating campaign to the expurgations of the now useless gas, steam and hot water pipes from the floors and walls of our buildings.

How, then, it will be asked, shall we communicate with the outside world? How "get about" within our own confines? How light our streets and houses? How cook our food and warm our baths, and how brighten our houses with color and glow as we now do with the cheerfully blazing log? To ask these questions is but to elicit the answer you had already anticipated, at the name of the univeral agent we shall employ. There is but one so omniserviceable. We call it electricity; we know not what it is, but what we do know is that scarce one suggestion herein made in respect to its attributes but has been practically realized to the personal observation of us all.

Why, then, indulge ourselves in arguments? Are we not already convinced? Aye, but more is wanted. We are, 'tis true, an enterprising and progressive people, but we are growing large, we are developing inertia, and, like all else in nature, as we assume ponderous proportions we become unwieldy and inflexible. The antidote of enthusiasm is our only salvation, and no enthusiast is worthy of his calling who contents himself with silent acquiescence in his propositions. He must incite by the force of his own convictions the latent moving quantity that is inherent in all human inertia, however disproportioned to the mass it may have become. It is only thus that progress is perpetuated in a community grown selfish, sluggish and phlegmatic by reason of having been overfed.

Necessity for more particular elucidation thus being recognized, we shall proceed to instance the practical application of electricity to such of our cases as are within common knowledge, and then to indicate how it may be qualified to fill all the other offices we have so ruthlessly vacated. To simplify our task we will classify the work to be done.

First—We must be in instant, intelligent touch with the outside world and with each other. We must therefore have the telegraph and the telephone.

Second—We must hasten the dawn and prolong the setting of the day, to which end we must have light.

Third—We must move rapidly to and fro in squadron and in detachment and transport our baggage. We must therefore have quick transit, omnipresent for men and supplies.

Fourth—We must eat, drink, and keep warm and clean; hence we must have heat.

Analyzing this, we find we require that electricity shall give us:

1. Communication.
2. Light.
3. Power.
4. Heat.

We place them in this order to the end that we may the more readily dispose of them. The first and second we will call "dead issues" as pertinent to this discussion, and will, therefore, bury them, as has already been literally done to a moderate extent; at all events the funeral cortege of these two very eminent unsightlies is now in procession. The third is power; but power universally applied, and hence demanding serious treatment if we would calm the nerves of those whom we have despoiled of their elevated cars, their horse cars, their drays and trucks, their factory elevators, their pumping engines, their fire engines, their street sweepers, and even their carriages.

I.

IDEAL RAPID TRANSIT.

The first and most important of the many applications of electric power we shall illustrate is at the same time the most difficult, and presents a problem which the electrical engineers of the world have up to the present time grappled with in vain. This is the reliable operation of heavy traffic trains. If this problem can be successfully solved there is but one other (of which more anon) before the engineer to effect an absolute realization of all that has been herein suggested. To this matter we shall, therefore, give more than passing attention, particularly as in it is involved the rapid transit inquiry of the hour. Moreover, the writer has had such identification with the efforts of such pioneers in this line as Edison, Sprague, Field and others as should eminently qualify him to discover to the reader wherein they failed, and to at least indicate how success can now be achieved.

The problem does not consist in transmitting a sufficient amount of electric energy to the motors throughout the line; that is simply a matter of investment in copper wire. Nor does it lie in the sufficiency of the power capacity of a motor; that is again only a matter of iron and copper. Since, then, we can deliver ample energy to the motor at any or all points of the line, and can there convert that energy into abundant motive power to move any and all trains, however heavy and at whatsoever speed, what, then, is the obstacle so apparently insurmountable that even the Napoleon of inventors is baffled by it? To intelligently expose this obstructive characteristic of the electric motor to the lay mind, we are perforce compelled to digress a trifle. Since, however, the matter is of such vast importance, and since we promise that the digression shall be only an apparent one, leading in reality directly back to our objective point, we risk the charge of discursiveness and the consequent loss of hold upon the mind of our reader in order to do so.

The fundamental characteristic of the steam engine is slow speed, and high speed is only obtained at the expense of its depreciation and by a sacrifice of its economical efficiency. On the other hand, we have in the electric motor a characteristic which is the diametric opposite of this. Its maximum efficiency is coincident with its maximum velocity, and its quick destruction is an inevitable consequence of a reduction of its speed below a certain narrow margin of its normal rating. It will from this be readily understood that the great inertia of a heavy train can be more safely and economically overcome by the deliberate movement of the steam engine than by the lightning-like velocity of an electric motor. The two may be aptly compared to a trained and a raw team of horses; the old team will settle down in their collars and with a steady pull await that result which their experience has taught them will inevitably follow. The spirited young bloods, on the contrary, will jump into their harness with incautious energy and effect only disaster in the form of broken straps, bruised shoulders and much human profanity.

Time and experience will temper the spirits of the too electric team, until they in turn become the counterpart of their elders; but the immutable laws of nature governing the inanimate world positively forbid any such educational progress to the electric motor. Its spirit and youthful incaution must ever remain its dominant characteristic, and, since the same undeviating laws determine that the inertia of matter must ever make demand of the element of time, it follows that, if we would successfully employ the electric motor, we must in some way afford it a freedom of movement independent of the duty we impose, and yet none the less require that that duty be positively performed. This sounds like a paradox, and in a certain sense it is, but the "impossible" has nevertheless been accomplished. Therefore, to permit our young team of horses to retain their high spirits and celerity of movement, and yet to effect an easy graduated movement of their load without the concomitants of bruised shoulders, broken straps, and profanity, is now within the realm of things practically realized.

Without going into a detailed description of the means by which this is accomplished, the general principle may be here mentioned for the purpose of showing how the electric motor may start independently of the car, and as it moves exert an effort increasing in the ratio of its movement until the energy expended is sufficient to overcome the inertia of the car. This accomplishes precisely what the trained team of horses does and avoids the destructive results which accompany the efforts of the inexperienced. We can, of course, give no proper idea of the practical application of the principle, but merely mention the general method of flexible connection with the axle.

With the removal of this sole barrier to the utilization of the electric motor for heavy traffic work, underground railways are instantaneously raised, metaphorically speaking, from the depths of sulphurous damnation to the very pinnacle of effulgent glory, and are literally rendered safer, purer, more salubrious, and lighter than is possible even to an elevated or surface road.

Pending the construction of our comprehensive arcadian system, it is within the power of the present elevated-railway management to give us ten-car trains where now a five-car train is given, and to take us from the Battery to the Harlem in one-third of the time that is now occupied, and that, too, without at any point attaining a greater maximum speed than is now attained; that is to say, to start and stop quicker than is now possible, and that without the spasmodic jerking movement heretofore inseparable from both the steam and the electric locomotive.

It is also within the power of the Grand Central tunnel authorities to give us absolutely pure and safe tunnel transit—a desideratum which the late accident has forcibly emphasized, and which Mr. Depew in effect says is practically impossible to realize. Legislative enactment cannot properly light a tunnel traversed by the steam engine, as the management can readily prove, by unanimous expert testimony, the folly of attempting to artificially illuminate the dense opaqueness of a London fog. The management therefore wisely conclude that such light as is employed should interpret only a sign of danger or safety. Mr. Depew says that in the last analysis the best signal appliances depend upon the human mind, that there is no power on earth to prevent an engineer from running past a danger, and the *Tribune*, in commenting upon Mr. Depew's able diagnosis of the signal system, says his psychological studies are deeply interesting.

Now, Mr. Depew's conclusions and the *Tribune's* comments thereon are alike able and thoughtful in their way, but both are founded upon the mistaken hypothesis that the present order of things is final, whereas both have before their daily vision evidence of the presence of a superior order of things which only needs the open door of encouragement to become the established order, and thus to effect a total abolition of Mr. Depew's premises and render the psychological studies of the *Tribune* inappropriate.

Recalling the adage that "Fools step in where angels fear to tread," it is with some hesitation that the writer ventures to instruct such high authorities, but conviction is an irresistible force, and in this instance compels the writer to attempt the task.

We will therefore analyze the tunnel problem, not through Mr. Depew's limited glasses, but in a broader light of science, as now practically applied and possible of achievement, and see whether or not Mr. Depew's limitations are correct or the *Tribune's* psychological studies pertinent.

A tunnel is essentially a realm of darkness. The safe movement of dependent physical things demands light. The first essential is, therefore, to effect artificial illumination. The darkness is a fixed quantity. A fixed quantity of light, other conditions being equal, will therefore effect a uniform and constant illumination sufficient to render all things more certainly and clearly discernible than in the variable light of day.

To effect this we must have, of course, a pure atmosphere, not subject to change by being alternately charged and freed of heavy vapors, but which is constantly kept at a high standard of rarity by reason of there being no adulterative forces present. This atmosphere is at once obtained when we substitute the electric motor for the steam locomotive. This radical change gives us the equal conditions requisite to obtaining and maintaining an absolutely fixed perspective quantity in our tunnel.

Having thus provided a constant light in which Mr. Depew's "human mind" can exercise itself with the greatest ease and precision, let us now proceed to ascertain the extent to which we are dependent upon the activity of that mind for the element of safety. Electricity has been selected by us for our motive power. Electricity has long been used for the transmission of signals. We have therefore now combined in one agent a signaling and a motive power—that is, an agent which we may employ for the purpose of conveying a signal to an objective point, and at that point evolving from it a power ample to enforce that signal. Even the original formation and transmission of this signal may be independent of human intelligence, and thus to so completely eliminate Mr. Depew's final human mind as to make it indifferent whether it be present with the moving train, in the switchbox, or enjoying elsewhere the satisfaction which comes from feeding its carnal habitation.

To accomplish the automatic control of a moving train impelled by a power within itself is one thing, and one that has admittedly defied the brain of inventive man. But to accomplish the absolute control of a train impelled by power external of itself, and therefore controllable from fixed or moving points, indifferent as to distance, is quite another thing, and one easily within the ingenuity of the ordinary electrical engineer. The failure of electric signals at critical moments has imbuded the mind of the railway manager with the belief that electricity is unreliable. There is a measure of foundation for this, but when we have at command the great electrical force requisite to move the traffic of the line it is competent for us to secure an operation as absolute and positive as the throwing of a switch by the hand of a man and, withal, infinitely less subject to "mental lapses."

The new block system will not be a system of visual signals, but will be a system in which the motive power of the second train entering a block will be withdrawn or reversed by the mere fact of its having entered upon a block already occupied by another.

Under this system Dr. Depew may send his trains from his Grand Central Depot to his steam horses beyond the Harlem in quick succession without the possibility of collision, even though his final human observation be absolutely absent.

The arcadian electric tunnel system modeled upon the foregoing outlined plan must traverse the main arteries of travel, both north and south and east and west, and be of such ample proportion and convenient arrangement as to stations and exits as to afford accommodation to all possible traffic. It should provide "express" and "accommodation" independent of each other, but traversing the same general routes and intersecting at convenient points for an exchange of passengers. It should be constructed of iron and in such manner as to absolutely prohibit all percolation of moisture or gases, to the end that a dry and pure atmosphere be maintained.

Ventilation should be provided for by the construction of frequent shafts opening to the surface and fitted with electrically operated exhaust fans, the power to energize which would of course be obtained from the conductors which supply the traffic line. Quick operating elevators of ample capacity should be part of the equipment of every

* From *The New York Recorder*.

station and should derive their power also from the main conductors.

II.

THE STREET OF THE FUTURE.

Thus electricity would be employed to move the trains, to block them, to illuminate and ventilate the tunnel, and to receive from and deliver the traffic to the surface. The street surface, being thus freed of all movement save of a distinctively local character, may now be dealt with in a manner to carry out practically our suggestion of obliterating the track, the surface car, the dray, the cab and their complement of horses.

If we bear in mind that the purpose of an iron rail is simply to afford a smooth vehicle track, it will not be difficult for us to imagine that, given a street surface approximately as smooth as an iron rail, we could have a track whose width was coincident with that of the street, and thus be enabled to propel over it all vehicles of every kind and character as readily as the tram car is now propelled upon its narrow thread of iron.

This, then, is our initial step toward universalizing the method of propelling all surface vehicles. We must adopt a uniform and smooth pavement and must maintain it always in good repair. The modern asphalt, properly constructed, gives us just what we need. Upon its surface we shall employ only broad-wheeled, electrically propelled vehicles, permitting horses only for purposes of pleasure and recreation, and requiring all such to be fitted with anti-slipping shoes of cork, paper, wood or rubber. In order to supply the requisite electric energy to our omnipresent surface wagons, cabs, etc., we must carry it with us, as it would, of course, be impracticable to transmit by wire to such indiscriminate traffic.

That we may not be charged with impracticability we will here again digress somewhat and consider the present commercial aspect of electric storage, for unless we can obtain an efficient and durable storage battery we shall have to retain all the barbarisms of our present street movement, including the pavements, the true and only secret of the radical betterment of which is "stored electricity."

It is, of course, well known that electricity is to-day generated and transported hither and thither and transformed at will into electric light, electric heat and electric power. It is not known, however, that this industry has grown to such proportions as to involve the employment of millions of capital and thousands of men, and that for a considerable variety of work electricity so stored, transported and reconverted is even now an actual economy over other methods.

Such, nevertheless, is the fact. Moreover, great attention is being paid to the elimination of some minor defects now operative to prevent its more general adoption for commercial purposes. It will not tax our credulity, therefore, to any extent to accept the perfectly commercial solution of this storage problem as guaranteed, upon the appearance of any decided demand such as we have herein outlined.

As to the commercial aspect of electric traction for the propulsion of street vehicles, a little analytical study of the problem will suffice to show that there is no great step to be taken. We already have some seven thousand or eight thousand street cars electrically propelled in the United States alone. In this we have proof of the superiority, economically and otherwise, of electric over horse power for such purpose. Since, therefore, this particular form of vehicle can be economically propelled there is no reason why any and all other forms may not be under like conditions. We are then reduced to the examination of our altered conditions.

In what respect have we changed them? We have, as before mentioned, broadened our iron rail to give a track that will comprehend the entire street. That expansion of surface introduces no new conditions, providing we retain a surface equally smooth and as uniform. This we do with such close approximation, by means of asphalt, as to preclude the necessity for considering our conditions changed at all in this respect. Thus we find that the only real change is in the method of supplying our vehicular motors with the electric current.

We are compelled, by reason of not following a fixed track, to employ storage cells or reservoirs and carry them upon each and every vehicle. Let us see to what extent this has been done. Again, we go back to the street car, and we find storage cars employed in some instances in preference to the employment of a wire, the sole object being to meet the prejudice which exists against a wire strung over the street surface, the only disadvantage of which is unsightliness. Therefore, the storage principle cannot be held to be too remote for practical consideration. It is true that advances must be made in the economical efficiency of the storage cells of the present day, but, as we have before remarked, the general demand will undoubtedly accelerate this development. Moreover, the question of speed is an important factor in vehicular propulsion. In our surface wagons we need to move at a speed not greater than six or seven miles per hour, hence we may obtain ample power from comparatively light motor and battery weight.

The fire engine, the street sweeper, the street sprinkler and the ambulance, though but little required in our arcadian order, would, one and all, be electrically equipped and therefore instantly at command in case of need.

III.

A TWENTIETH CENTURY HOME.

Having thus disposed of the matter of substituting electric power for the street horse, we will now pay our respects to that almost equally obnoxious force, the stationary steam engine and its attendant evils. Upon the subject of substituting electric motor for this branch of steam power it is scarcely worth while to dwell, except, perhaps, to contemplate the changed aspect of a city viewed from its housetops.

How different the prospect! No smoke, no vapors, no semi-consumed carbonaceous atoms to dilute the pearly rain-drop or veil the face of heaven's orbs, all as pure and fresh as the morning dew and as neat and clean as a meadow in spring-time. In fact, every housetop, it is easy to contemplate, has been transformed into a bower of living, vital green upon which no breath but of heaven ever falls. We are led thus to step aside and view the work of the silent procession of science at this particular moment because we have reached a natural resting place.

All our journey thus far has been laboriously achieved; henceforth our pathway will be easy. Let the substitution of electric power for the present stationary steam engine and furnace once become general and all else that we have or shall outline, will follow as naturally as day follows night, and for the same reason obedient to natural law. It is, therefore, useful to cast about us for evidence of the thitherward tendency of the stationary electric motor? Is it with us, and what is it doing?

Happily we can all answer this, and more happily yet scarce two of us will cite identical applications, so numerous and varied have they already become. Suffice it to say that there is no work now being performed by steam, gas, air or other motive power but what can be more satisfactorily and economically performed by electric power, given a general supply of electricity such as we now have of gas or water. The elevator, the printing press, the factory plant, the pump, the sewing-machine, etc., let their demands be great or small, can be, and in fact are now being, operated by the electric engine. Simply pass an anti-steam law, organize a board of electrical motor control and let Mayor Grant rise in his wrath and order quenched all furnaces in the city and the deed is done. Why not? Has not the furnace, the boiler and the defective flue been far more potent of slaughter than the aerial wire? And is there any difference save in degree between a legal command to destroy an investment in poles and wire and substitute therefor one of conduits and cables, and one commanding the abolition of the vastly more dangerous and obnoxious fiery furnace and the adoption of the cleanly and unobtrusive electric motor?

If there is, the writer confesses an obtuseness incapacitating him from seeing it. At all events the gain to the entire community would be infinitely greater in the latter case. The burial of the wires simply removes an eye-sore and a menace to life and property. The general adoption of the electric motor with the consequent total abolition of fuel consumption (of which more anon) realizes the dream of modern philanthropy. It presages the fall of the factory with all of its concomitant horrors of indiscriminate associations, for where a power exists capable of indefinite subdivision with practically no loss of economy, the home of the artisan becomes his workshop, as in the hamlet of the Swiss glass-cutter, whose wheel is ever in motion by virtue of the mountain stream, by the side of which he dwells.

There is nothing visionary in the prospect of a family employing at their home beyond the Harlem an electric motor, by the aid of which each performs his or her work in comfort and comparative luxury. The saving of time and money now lost in going to and fro would in one year pay the cost of such domestic power plant as well as the cost of operating it. It is not difficult to conceive that under such circumstances a vast army of women and children not now employed would find themselves suddenly endowed with earning power. The father and brother would become the teachers, and thus the word "apprentice" would pass from the language of labor. Trades unions strikes and the like would die a natural death, or at least become so disorganized as to lose their pernicious power.

In discussing the abolition of the steam engine we have assumed the total abolition of the furnace fire of which we promised more anon. This brings us to the treatment of the final application of electricity to complete the need of our arcadian city, viz., electric heat.

In order to simplify matters let us recall that, having substituted electric power for steam, we no longer need heat for power purposes. Our remaining needs are, therefore, bodily warmth and cooking. Are these obtainable? If not, why not? If so, how?

Electricians of ability, but with a capacity of seeing farther into the depths of abstruse science than of forecasting the commercial horizon of that science applied, will tell you that electric heat is a delusion and a snare, and, like that *ignis fatuus*, perpetual motion, is only pursued by the blind ignorance of the inexperienced. With these the writer begs leave to disagree, even though the smile of scorn may threaten to abash him.

A man who has warmed his own den, cooked his own steak, mulled his own wine, brewed his own toddy, aye and warmed his own bath solely by the aid of heat electrically generated, and who has farther measured the quantity and computed the value of the electric current required in the operation, is not one to whom it can be safely said that electric heat has no future.

He is prepared to tell you that if you would to-day abandon your furnace, your hot water boilers and pipes, your kitchen ranges and your grates and chimneys, and substitute therefor electric heating apparatus and an electric meter, the experiment will be performed by the meter; that is to say, there is no problem but the problem of cost, and that, as we have before indicated, is merely a matter of the scale upon which electricity is utilized. If, for illustration, electricity were to-day employed universally for such purposes as it has already been proven to be more economical and better adapted than other agents, such as lighting and power, then its cost would be so greatly reduced as to render its employment for heating no more of an extravagance than a thousand other things we are daily indulging ourselves in.

Furthermore, the general adoption of electricity for heating would of itself so increase the output as to enable its purveyors to contract the supply of all heat required in any given residence for a less sum than is now expended for that purpose.

Now let us take a retrospective glance at the—shall we say mischief we have wrought? We have put all heavy traffic in clean, dry iron tubes at a depth sufficient to be clear of all interference with surface conditions. We have brilliantly illuminated and thoroughly ventilated and raised and lowered and transported our passengers, all with one and the same power—electricity. The elevated structure has been sold to the trunk line railways for bridge purposes to enable them to cross all village streets and common roads above grade in compliance with legislative enactments which have resulted from our metropolitan arcadianism; or, perchance, they have been transferred from their present location to the city's water front, and there re-erected as an ornamental balustrade upon our dock system and utilized for the improvement of our terminal and shipping facilities.

We have shipped our street cars to our country cousins, to be used as pigsties, have recast our iron rails for the lower regions and have employed our cobblestones as ballast to return to Sicily the ships that have come hither with the asphalt with which we have paved, like unto a mirror, all the surfaces of our streets.

We have given eternal freedom to the draught and car horse, and out of the abundance of our gratitude at our own emancipation and in sympathy with the poor Indian we have sent him all such with our blessing upon both. We have installed in his place on the street self-propelling, noiseless and swift perambulators, and on the site of his habitation we have built homes for ourselves.

We have shipped our stationary steam and gas engines to China and the Congo State to grow up with the country, while we ourselves keep step with a later development of our higher civilization. We have sent our gas reservoirs to the oil fields, where they can be perpetuated in their capacity of standard monopolists. The city has subsidized the general electric supply company of Ward's Island by making it a free contribution of the furnaces and boilers of the steam-heating companies and has utilized the gas and steam mains to provide an independent water supply for the Fire Department and for flushing its streets. We have donated our stoves to the missionaries, who, having converted the South Sea Islanders to our ideas of dress, now need to provide means to keep their bodies warm.

We have melted up our copper boilers and drawn the metal into conductors for our electric service, and have filled our erstwhile hot water pipes with cooling zephyrs laden with the odors of Araby, and thus caused the absolute migration to other climes of the pestiferous cockroach and his sisters and his ants.

We have caused the builders' emblem to take root upon our housetops and to grow to lusty proportions, and now our linen is whitened as of snow under its umbrageous foliage with no contamination of drifting atomic carbon. Epigrams are no longer made upon Bridget's sudden taking off by the explosive and otherwise festive kerosene. Our streets are lined with foliage whose sere and yellow leaf comes not out of season but only as nature calls.

Our pavements are swept with broom corn and no longer with hay rakes. Our horses, now our companions and not our servants, tread daintily and comfortably in shoes of elastic quality and no longer on rigid steel. Our food is now prepared by the chef of the corner caterer, and is cooked by the "lady of the house." The débris of the after-meal is reduced to ash in our electric furnace, and garbage has become an unknown quantity.

The ash-barrel is no longer known save as preserved in bric-a-brac by artists of historical proclivities. Our chimneys are now mere ventilating shafts, and the sportive swallow resides there in comfort and safety. Our drawing rooms are alive with color without odor, with the glowing log which is yet not consumed and giveth forth no ash to vex the soul of our loving spouse.

Our bath is tempered by our auto-electro heater, and set to any degree of temperature that may be found most soothing to the glowing, healthful body of our arcadian citizen.

To the end that serious thought may be given to the subject herein discussed, the writer, not unmindful of his business repute, respectfully submits that he is ready and willing to place his personal time, experience and reputation at the service of capital in the practical and commercial consummation of any one or all of the applications of electricity herein suggested.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

Stocks Quiet.—The general market for stocks has inclined to dullness during the week. Particularly is this true of railroad shares, and notwithstanding a good bank statement the market showed no life at the close of the week. Money has been easy on call, and loans closed at 2½.

Consolidation.—There are many rumors concerning a possible consolidation or purchase of the Westinghouse electrical interests by the Edison General Company. There seems to be no decided information concerning the truth of the rumors, nor is it likely that the investing public is going to know anything about the matter, even if such negotiations were on hand, until the deal is consummated. We trust, for the general good of the electrical business, that the report of consolidation is unfounded. Business nowadays seems to be running toward consolidation more than ever, and from the standpoint of the companies the movement is generally to their betterment, as expenses are greatly reduced and salaries almost cut in two. From the standpoint of the public, exclusive of investors, consolidation cannot be received with such favor. The more competition we have and the more people employed, the better. It costs a great deal of money to start in open rivalry with the leading companies to-day, and the activity and experience of their agents make competition a hard struggle. These companies are on a strong financial footing, with the exception of the Westinghouse company, and doubtless that corporation will soon be in a like position. The stock of these corporations, representing almost a monopoly in a great and growing business, can but be considered a fine investment, and from the investors' outlook any consolidation that takes place would make the new stock representing the consolidation of greatly increased value.

Westinghouse.—The following statement recently appeared in a leading financial journal of Pittsburgh, concerning the matter of the election of officers of the Union Switch and Signal Company. Capital has been made of the matter in order to affect the electric company's stock, and the statement shows what injustice has been done Mr. Westinghouse:

"The view taken of the policy pursued by A. T. Rowand and his Boston combination was anything but favorable, and some of the criticisms were very severe. While it is not believed that the election can be successfully contested on legal grounds, or that Mr. Westinghouse will make any move in that direction, the belief is universal that the wishes of the stockholders were utterly disregarded in a great many cases. While it is true, say the critics, that the proxies were given in the joint names of Messrs. Westinghouse and Rowand, the great majority of those who signed and sent them in were not aware of the fact that within a year past the personal relations of the two gentlemen named had undergone a radical change, the latter becoming, as asserted, the bitter enemy of the former. Had this been known, very few proxies would have come into Mr. Rowand's hands. It is considered that great injustice has been done Mr. Westinghouse in thus summarily depriving him of any voice in the management of a corporation created and fostered by himself, and whose very existence to-day is due to his generosity in borrowing money on own name and collateral to keep it afloat, a large part of its indebtedness of some $2,100,000 being due to him. Mr. Rowand' friends claim that a considerable portion of the proxies he voted were in his own name, that of Mr. Westinghouse having been erased; that even without these proxies, covering only about 8,000 votes, the Boston contingent cast more than two-thirds of the 30,000 votes against the Westinghouse people, he merely going with the strongest side. Among all the brokers and stockholders seen no one questioned the legality of the election held, and they ridicule any attempt to set it aside. A tour among the stockholders disclosed the fact that in some instances the name of Mr. Westinghouse in the proxies was stricken out and that of Mr. A.

T. Rowand permitted to remain. Those who did this knew Mr. Rowand's intentions. It is a fact that Mr. Rowand has made no secret of his intention among certain people."

Thomson-Houston.—The statement comes from Boston that the Thomson-Houston company has started up on the new single running gear motors, and that an extra force has been put on to turn out a large quantity of these motors. The stock has not been very active during the week, but brought good prices.

Thomson-Houston Welding Company.—Work has been commenced on the new projectile factory of the company. This department is connected with the United States works, and when in full operation will employ 1,200 hands.

Edison.—The company has declared the sixth quarterly dividend of two per cent., payable May 1st. The stock is not high at the present figure, and its ready market and good interest (eight per cent.) make a good investment to put in the safe and allow the dividends to accumulate.

Mexican Telephone Stock has been attracting attention of late. The company is said to be remitting $1,500 to $2,000 per month to the Boston office.

Phonograph Stocks.—These stocks continue to be lifeless. There is no good reason for it. The property and business represented are very valuable, and the stock ought to bring good prices. The Columbia Phonograph Company gives notice of the payment of the fourth dividend of one per cent. on its capital stock. If the business of a comparatively small town like Washington can be made to pay, certainly the larger cities should show good earnings. F. Z. M.

The Closing Quotations of electric stocks, from F. Z. Maguire & Co., electrical securities, 18 Wall street, New York, on Saturday, March 21, 1891, in New York, Boston and Washington were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co	100	86,200,000	79¼	80
American Telegraph & Cable	100	14,000,000	81	82
Central and South American	100	5,000,000	....	....
Mexican	100	2,000,000	....	....
Commercial Cable Co	100	7,716,000	104	109
Postal Telegraph Cable	100	5,000,000	....	....
Edison General Electric Co	100	9,503,500	100	105
" " deferred	100	2,496,500	....	....
Consolidated Electric Light	100	1,922 400	....	....
Edison Electric Illuminating Co.	100	2,567,800	....	....
United States Electric Light	100	1,500,000	....	....
North American Phonograph	100	6,200,000	....	....
BOSTON.				
Thomson-Houston Electric Co	25	6,000,000	43½	44
" " preferred	25	4,000,000	25½	25½
" " Series C	10	400,000	*9¼	10
" " Series D.	10	120,000	6½	7
" International Co.	100	1,000,000	....	....
Thomson Welding Co.	100	1,000,000	....	....
" European Welding Co.	100	1,000,000	....	65
Ft. Wayne Electric Co.	25	4,000 000	12¼	12½
Westinghouse Electric Co.	..	.....	11¾	12
Telephone:				
American Bell	100	12,500,000	....	198½
Erie	100	4,800,000	48¼	48½
New England	100	10,304,600	50	51
Mexican	10	1.280,000	85c.	95c.
Tropical American	10	400,000	70c.	90c.
MISCELLANEOUS.				
Edison Phonograph Doll	10	1,000,000	....	1
WASHINGTON.				
Pennsylvania Telephone	50	750,000	25	....
Chesapeake & Potomac	100	2,650,000	57¼	....
American Graphophone	10	600,000	5⅝	....
United States Electric Light (Washington)	100	300,000	170	....
Eckington and Soldiers' Home Electric Ry.	50	352,000	56½	....
Georgetown and Tennallytown	50	200,000	60	....

*Ex-dividend.

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

Chicago	$225@$245	Cumberland	$60@ $62
Central Union	56@ 57	Wisconsin	118@ 120
Michigan	85@ 86	Bell of Missouri	160@ 165
Great Southern	30@ 34	Iowa Union	20@ 22
Colorado	34@ 36	Missouri and Kansas	54@ 56
Rocky Mountain Bell.	40@ 43		
ELECTRIC LIGHT STOCKS.			
Chicago Arc Light and Power	$96@ $98	Chicago Edison	$140@$150

NEW INCORPORATIONS.

The Collingswood Water and Light Company, of Collingswood, Pa., has been incorporated, with a capital stock of $25,000.

The Athol Gas and Electric Company, of Athol, Mass., has been incorporated, with a capital stock of $25,000. The officers are: President, G. C Moses; treasurer, F. R. Davis.

Temple, Tex.—The Temple Electric Light Company, with a capital stock of $30,000, has been organized with J. F. Smithers as president and N. K. Smith, secretary. This company will establish an electric light plant at once.

The Universal Electric Manufacturing Company, of Chicago, has been incorporated with a capital stock of $20,000 for the manufacture of electrical inventions. The incorporators are H. M. Day, J. Elliott and J. Usler.

The Pecatonia Electric Light and Power Company has been incorporated at Pecatonia, Ill. The capital stock is $10,000. The company is to furnish electric light and power. The incorporators are: J. W. Wolvin, F. L. Colby and B. A. Knight.

The Electric Bulletin Company, at Chicago, with a capital stock of $50,000, has been chartered for the manufacture and operation of railway train annunciators and other devices for advertising. The incorporators are: F. A. Jennings, G. A. Cross and P. R. Jennings.

The Atlantic and Western Telephone Company has been incorporated at Chicago, Ill., with a capital of $5,000,000, to manufacture electric speaking telephones. The incorporators are: Henry P. Caldwell, Henry C. Strong, D. A. Strong, Edw. B. Springer, G. J. M. Porter and George M. Brinkerhoff.

The United States Street-Car Motor Manufacturing Company has been incorporated at Chicago, Ill., with a capital stock of $300,000, for the manufacture of motors and cars for street and elevated railways and mechanical devices. The incorporators are: William B. Cunningham, Charles F. Vogel and Henry H. Kenedy.

Bristol, Tenn.—The Bristol Gas, Electric Light and Power Company, with a capital stock of $100,000, has recently been incorporated. This company has an electric light plant already in operation and will shortly place additional machinery. The same company also intends erecting gas works, and the work of constructing this plant has already commenced.

The Gouhegan Electric Light and Power Company, of Milford, N. H., has been incorporated, with a capital stock of $60,000. The officers are: President, Theodore P. Dresser; secretary, Geo. A. Beatty; treasurer, W. A. Clark, Jr.; general superintendent, C. E Pendleton; directors, T. P. Dresser, G. A. Beatty, C. E. Pendleton and W. A. Clark, Jr.

The Davy Electric Suspension Transportation Company, of Chicago, has been incorporated with a capital stock of $10,000,000, for the construction and operation of a system of suspended carriage for the transportation of passengers and freight and other matter, and to do a general transportation business. The incorporators are G. W. Cole, J. W. Davy, W. W. Thrader, and L. A. Bryan

AFFAIRS OF THE COMPANIES.

The Winston Electric Light and Motive Power Company and the Winston Salem Street Railway Company, of Winston, N. C., have consolidated under the name of the Winston-Salem Railway and Electric Company, with the following officers: President, J. H. McClement; vice-president, E. L. Hawks; secretary, W. H. Mason.

The Olean (N. Y.) Electric Light and Power Company recently held a meeting of the stockholders to determine whether the capital stock of said company shall be increased $5,000, to consist of 50 shares of $100 each, in addition to the present capital stock of said company. The trustees are: J. V. D. Coon, N. V. V. Franchot, Wm. N. Irish, F. W. Higgins, F. W. Kruse and C. S. Stowell.

The Bristol (Pa.) Electric Light and Power Company held its second annual meeting on the 19th inst., and a five per cent. dividend was declared. Mr. Francis Fenimore, having been elected burgess of the borough of Bristol, declined a re-election as president of the company. A vote of thanks was tendered him for his able administration of the affairs of the company. The following officers were then chosen: George A. Shoemaker, president; A. Weir Gilkeson, secretary; Charles E. Scott, treasurer. G. A. Shoemaker, W. H. H. White, Leopold Landreth, Frank F. Bell, A. Weir Gilkeson are the directors.

The American Projectile Company's payments on stock offered to the shareholders of the Thomson Electric Welding Company are due 25 per cent. the end of March, the same May 1, and the balance in equal payments when called for. The subscription is reported full, and some stockholders have asked for more than their relative share. An outside syndicate stands ready to take to the amount of $100,000 stock not wanted by shareholders. An officer of the Thomson Electric Welding Company expresses the opinion that the projectile company will pay a dividend the first year of its operations. The welding company has received an order for four more plants from a Johnstown (Pa.) firm, which has one plant already, the new machines to weld as high as eight square inches. The welding company now has 125 out, and to be shipped directly, the whole drawing royalty. Some additional plants have been contracted for.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, March 23, 1891.

The Interior Conduit and Insulation Company has purchased the business of the Bergmann Electric and Gas Fixture Company of this city.

Perret Motor Plants.—The Lancaster (Pa.) daily *New Era* has installed a Perret motor plants of 40 h. p. for running it presses and the New York *Commercial Advertiser* will have in its new building on Park Row a 20 h. p. Perret motor for operating the Hoe presses. The Electron Manufacturing Company has been doing a good business in power plants.

Franklin Electrical Society Notice.—The meetings of the above society will hereafter be held on the second and fourth Saturdays of the month. The next meeting will be held Saturday, March 28, at 8 P. M., at rooms 239-241 East Fifty-seventh street. A paper on "Electric Traction" (elementary) will be read by M. L. Newman. Visitors are invited to attend.

Mr. John Pettit, of the Bennett building, this city, is the agent for the Electrical Exchange building, a most conveniently situated and well-arranged business block of seven stories. This building, which is situated at Liberty, Washington and Cedar streets, is constructed especially to secure to the electrical interests convenient neighboring offices, such as, for instance, those in the well-known Hathaway building, at 620 Atlantic avenue, Boston.

Mr. Frederic Nicholls, manager and secretary of the Toronto Incandescent Electric Light Company, Toronto, Canada, called on the principal supply and manufacturing companies during the past week and made some heavy purchases of electric light supplies, and also secured the exclusive Canadian agency for the Crocker-Wheeler motors and several other specialties. As is well known, Mr. Nicholls is to open an electrical supply house in Toronto, and will carry in stock, ready for immediate shipment, a complete line of supplies required in the construction and operation of the 200 central stations and the large number of isolated plants north of the border. In this enterprise Mr. Nicholls will be interested mutually with other gentlemen of the same high standing in business and social circles, and success seems assured from the start. Mr. Nicholls is also the editor of the well-known *Canadian Manufacturer*, secretary of the Ontario Manufacturers' Association, and is always prominent in all public spirited movements.

American Institute of Electrical Engineers.—At the regular monthly meeting of the Council, held March 17th, the following associate members were elected: Adolph G. Greenberg, salesman, Fort Wayne Electric Company, 115 Broadway, New York City; Walter E. Harrington, managing electrician, Alantic City Electric Railway, Atlantic City, N. J.; George W. Tuttle, storekeeper, Sawyer-Man Electric Company, 510 West Twenty-third street, New York City. The secretary informs us that the meetings of the Council are now held at 5 instead of 7 o'clock, P. M., on the third Tuesday of each month, the same dates as the monthly Institute meetings. The change of hour proves to be very satisfactory. The paper by Mr. Carty at the last meeting of the Institute was prepared in advance, so that printed copies were in the hands of all who wished to have an opportunity to discuss the subject after a careful study of the paper. This practice is a very commendable one, and Mr. Carty deserves the thanks of the members for his enterprise in this direction.

The Crosby Electric Company has appointed the Toronto Construction and Electrical Supply Company as its agency for Canada and the California Electrical Works as agency for the Pacific coast. Mr. Louis Walsh will start on a Western trip about April 1, taking his mascot, the "coon," along. Apropos of this an incident of Mr. Walsh's late trip to Boston comes up. It seems that Mr. Walsh and his very attractive negro were on the steamer "Pilgrim," of the Fall River line, when that steamer struck a schooner while passing through Hell Gate. Everything was consternation; passengers were shouting and screaming; steam was hissing, fog horns blowing, and pandemonium held full sway. The negro, with trembling lips grasped Mr. Walsh's arm and asked: "What under de sun am de matter, massa?" Mr. Walsh told the fellow to "keep cool and everything will be all right soon." The darkey, evidently not quite comforted, said: "Whar am we gwine, anyhow?" "Going through Hell Gate," replied Mr. W. "Oh, Lor!" exclaimed the thoroughly frightened darky, dropping on his knees, "is that whar we done gwine? I thought we were going to Boston." L. H. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, March 21, 1891.

The Pittsfield (Mass.) Street Railway is to be equipped with electric motive power and is to be running by June 1.

The H. E. Swift Manufacturing Company has leased a new factory at No. 1 Hartford street for its wholesale trade.

Messrs. Cutter and Wood will remove to 131 Pearl street, April 1, having outgrown their present accommodation at 35 Arch street.

The Economic Electric Company is in daily receipt of large orders for its lamps, which have reached a high standard of efficiency, as is attested by numerous letters from users of them.

The Eddy Electric Manufacturing Company, of Windsor, Conn., has just closed a contract with the American Encaustic Tiling Company, Ltd., of Zanesville, O., for an electric power transmission plant of 365 h. p. The dynamos will be 90 h. p. each, and the motors will range in size from 10 to 35 h. p.

The Tyer Rubber Company, of Andover, Mass., represented by Mr. F. H. Jones in New York and New England, is at present very busy. This company manufactures a full line of druggists' sundries and soft and hard rubber for electrical purposes, including the celebrated "Tyrian" rubber tape. The Boston office is at 50 Bromfield street.

The Eastern Electric Supply and Construction Company has just issued a very complete catalogue and is now mailing the same to its numerous patrons. The increasing business has necessitated a removal to more commodious quarters, and the company has leased the large double store at 28 and 30 Oliver street, which will be occupied about April 1 next.

Franklin Park Railway.—A meeting of interested parties was held at Lynn, Mass., recently, looking to a combination of interests in the matter of an electric line from Franklin Park, in Boston, to Lynn, via Revere Beach, a distance of 13 miles. The fare proposed for the entire distance is 10 cents. It is claimed that the time could be shortened materially over that made by any of the present routes, besides giving patrons of the road a beautiful ride along the shore.

Mr. C. B. Burleigh, superintendent of the isolated lighting department of the Thomson-Houston Company at Lynn, Mass., is the happy possessor of the horse Butcher Boy and a complete outfit consisting of carriage, harness, robes, etc., having received the largest number of votes for the same at a recent contest. Mr. Burleigh's many friends will be pleased to hear the result, and it is confidently expected that there will be some record-breaking the coming season.

The Pettingell-Andrews Company, through its energetic agent, Mr. Levi Cofren, has secured the contract from the Springfield electric street railway, and also the Holyoke and Hadley electric railway, to furnish all the feed wire, which consists of 000 and 0000 sizes. The Washburn & Moen Manufacturing Company secured the contract from the same companies for all the trolley and returning wires, some fifty miles or more. It is expected that both roads will be in operation some time in June next.

The Worcester (Mass.) Electrical Exhibition seems to be of increasing interest to the public, as shown by the large attendance daily. THE ELECTRICAL WORLD is the only electrical journal having space there, and notwithstanding that hundreds of copies of the paper have been distributed the demand is greater than the supply. Mr. H. H. Bigelow, the manager, deserves great credit for the success he has attained in perfecting the various details, organizing excursions on the several railways, and in numerous ways making it possible for the people to visit the exhibition cheaply and expeditiously, believing as he does most thoroughly in the means of educating the masses in all that pertains to matters electrical.

The Consolidated Electric Manufacturing Company, of Boston, is to be congratulated on securing the services of Mr. Charles E. Bibber as its general manager. Mr. Bibber was born in Portland, Me., in 1863, and is but 28 years old. He started early in life with his father, who was a machinist and engine builder in Portland. In his spare moments Mr. Bibber studied civil engineering, and later went to Boston to perfect his studies, which he paid for by hard work at leisure moments. After one season at his chosen profession Mr. Bibber, then 20 years old, was attracted by the unusual activity in the electrical field, and decided to join his fortunes with the Boston Electric Company, and after good service with this company, during which time he studied carefully all the practical applications of electricity, and one year's experience as salesman on the road, he resigned and engaged with Messrs. Seth W. Fuller & Holtzer, afterward Fuller, Holtzer & Co. When that firm dissolved Mr. Bibber accepted a position with the firm of Holtzer & Cabot, now the corporation known as the Holtzer-Cabot Electric Company, and he has continued with them up to the present time. Mr. Bibber's experience has been thorough, and he well understands the manufacture of supply details. The Consolidated Company, which he now directs, has recently reorganized its forces, having new management in every position. C. A. B.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY TRUST BUILDING, PHILADELPHIA, March 21, 1891.

The Fort Wayne Electric Company is installing a 600 incandescent light Slattery plant for the Merchantville (N. J.) Electric Light Company, and a 75 arc light Wood plant for the Edison Electric Illuminating Company, of Westchester, Pa.

The Diamond Electric Company, which has the franchise for lighting in the 28th and 32d wards, has contracted with the Fort Wayne Electric Company for a 240 arc light plant, and with the Westinghouse Electric and Manufacturing Company for a 3,000 light incandescent plant.

The Thomson-Houston Electric Light Company, Philadelphia, has recently installed the following: A 100 arc and 2,000 incandescent light plant for the West End Electric Company, of Philadelphia; a 50 arc, 1,300 incandescent and an 80 h. p. generator for the Camden (N. J.) Electric Company; a 1,300 incandescent

light plant for the Lock Haven (Pa.) Electric Light Company; a 50 arc and 650 incandescent light plant for the Schuylkill Haven (Pa.) Electric Company; a 650 incandescent light plant for the Mahanoy City (Pa.) Electric Company; a 650 incandescent light plant for the Punxsutawney (Pa.) Electric Company; and three electric cars for the Shamokin (Pa.) Railway Company. W. F. H.

WESTERN NOTES.

Mr. Chas. P. Gilbert, general manager of the Detroit Edison Company, was in the city last week.

The Thomson Electric Welding Company has opened an office at 425 The Rookery. Mr. Harvey is in charge.

Mr. F. H. Whiting, of Denver, Colo., was a visitor in Chicago last week, en route from the Atlantic coast to Denver.

Mr. Andrae, of Milwaukee, Wis., spent a few days in Chicago recently, buying supplies and exhibiting a new device for drawing wire through underground conduits.

Mr. Frederick L. Merrill, 565 The Rookery, is distributing an attractive catalogue of the Loomis system of arc and incandescent lighting, for which he is resident agent.

New Quarters.—It is an assured fact that the Chicago Electric Club will, before long, settle in new quarters. The committee in charge has several favorable locations in view.

Mr. W. A. Ross, the well-known superintendent of the Kenton (O.) Gas and Electric Light Company, was presented with $5,000 worth of stock of the company a few days ago.

Mr. Wm. J. Schubert has been placed in charge as electrician of the Fredonia Electric Light and Power Company, of Fredonia, Kan., in place of Mr. P. P. Belt, resigned.

The World's Fair Electrical Bureau has been assigned permanent quarters on the fifth floor of the Rand-McNally Building. Correspondence with electrical people is desired.

The Bain Electric Manufacturing Company has just issued a neat and handsome catalogue. The book is a credit to the company and sets off the machinery illustrated in its pages to good advantage.

Lamp Factory for Seattle, Wash.—Mr. A. Smith, of the Plattsmouth Electric Lamp Company, of Plattsmouth, Neb., is in Seattle, for the purpose of arranging to bring the company's factory there. He will at once lay his project before the Chamber of Commerce, and he expects to have no difficulty in securing encouragement. The business of the company is the making of incandescent electric lamps. The Plattsmouth works turn out about 300 lamps a day and employ from twenty to twenty-eight skilled men. It is thought that the local demand alone will keep a much larger force employed. H. C. E.

SOUTHERN NOTES.

Glasgow, Va.—Work has commenced on the power house of the Glasgow Electric Light Company.

Morristown, Tenn.—The capital of the electric light plant is to be increased and more lights added.

Memphis, Tenn.—The contract for constructing an electric street railway will shortly be awarded.

Elkin, N. C.—Mr. T. J. Lillard, of this town, is preparing to erect and operate an electric light plant.

Fort Payne, Ala.—An electric light plant will be established by the Fort Payne Coal and Iron Company.

Phœnix, Ala.—The electric light plant will be established by the East Alabama Improvement Company.

Sumter, S. C.—An incandescent electric light plant is contemplated. The mayor of the city can give information.

Colorado, Tex.—An isolated incandescent electric light plant is to be installed by the Colorado Refrigerator Company.

Baton Rouge, La.—The electric plant of the Citizens' Electric Light Company is to be improved at a cost of $10,000.

New Iberia, La.—The electric light plant of the New Iberia Electric Light and Power Company is shortly to be improved.

Birmingham, Ala.—Messrs. Woodruff and Harris have been awarded a contract for the construction of an electric line in this city.

Little Rock, Ark.—A contract has been let by the Capital Street Railway Company for the erection of an electric power plant.

Leesburg, Va.—A franchise has recently been granted to Thomas Whipple, of Newport, R. I., and others to erect an electric light plant.

Johnson City, Tenn.—The Watauga Light and Power Company is having a track run into its yard from the East Tennessee & Georgia Railroad.

Leesburg, Va.—A franchise has been granted by the city council to Thomas Whipple, of Newport, R. I., for the erection of an electric light plant.

Bristol, Tenn.—The Electric Engineering and Construction Company has bought the Bristol Street Railway and will change it to an electric system.

Salem, Va.—The Salem Electrical Company is being organized with W. M. Nelson as president, D. T. Martin vice-president, and G. L. Colgate secretary.

Columbia, S. C.—A site will be purchased on the canal by the Columbia Electric Light Company, where a power house will be erected by that company.

Ocala, Fla.—A new building will shortly be erected by the Ocala Light and Power Company for its electric light plant, and new machinery will be added.

Clifton Forge, Va.—The Clifton Forge Electric Light and Power Company will make a contract for the use of the Brush system of arc and incandescent lights.

New Orleans, La.—A meeting of the stockholders of the Louisiana Electric Light Company was held on the 23d inst. with regard to an increase of the capital stock.

Walhalla, S. C.—The Norman-Carroll Company, with a capital stock of $10,000, has been incorporated, and among other enterprises will establish an electric light plant.

Key West, Fla.—The capital stock of the Key West Gas and Electric Light Company will be increased to $49,000, in addition to a $40,000 electric light plant which will be established.

Wilmington, N. C.—The Western Union Telegraph Company has finished stringing a line between Wilmington and Jacksonville, N. C. The office has been established at the latter place.

Chester, S. C.—Paul Hemphill, representing a stock company, has made the City Council a proposition looking to the erecting of an electric light plant and the construction of water works.

Sumter, S. C.—The Sumter Telephone Company has been organized with A. S. Brown, president; S. C. Baker, secretary and treasurer, and A. S. Brown, S. C. Baker, and R. O. Purdy as directors.

La Grange, Ky.—The La Grange Electric Light and Power Company has been incorporated, and will shortly establish an electric light plant. This company is now in the market for electrical equipments.

Augusta, Ga.—Owing to the recent high water in the river, the electric light and gas company has been unable to supply the city with light. The river reached 35 feet 6 inches, and is now rapidly falling.

Americus, Ga.—It is stated that parties from Baltimore, Md., have recently purchased the gas works and electric light plant of the Americus Electric Light and Power Company, and will improve and operate the same.

Austin, Tex.—An appropriation was recently made by the State Legislature for extending the Tensas and Madison telegraph lines to L'Argent, in Tensas parish. The work of extension will be commenced at once.

Appomattox, Va.—A company has been incorporated to purchase the battle-field near Appomattox and convert it into a summer resort. An electric railroad will be built from the station to the Surrender House.

Chattanooga, Tenn.—A contract has been awarded to the Thomson-Houston Electric Light Company, of Boston, Mass., by the Chattanooga and Northside Railway Company, for the erection of an electric power plant.

Atlanta, Ga.—The Thomson-Houston Electric Light Company is reported to have purchased the electric street railway of the Atlanta Street Car Company, and is negotiating for the purchase of other street car lines in this city, with the view of changing them into an electric system.

Fort Worth, Tex.—The Western Union Telegraph Company has completed the work of extending an additional telegraph wire along the "Cotton Belt" route into Fort Worth. The increase of business was so great that an additional line for commercial purposes became necessary.

Bristol, Tenn.—The Wiley Railway Electrical Signal Company has been formed for the purpose of manufacturing the electrical railway signal recently patented by C. E. Wiley. W. B. Ainsworth is president of the company, W. F. Rhea is vice-president, and J. A. Dickey, secretary.

Stanford, Ky.—An electric light plant to supply the towns of Stanford and Roland will shortly be established by the Stanford Water Works Company, which has recently been incorporated by J. F. Pulton, J. S. Hughes, C. F. Sturtevant and others. This company has a capital stock of $75,000. V. N. B.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

The Leland Stanford University of California.—(1) Is the Stanford University in session at the present time? (2) Has it an electrical engineering course? F. N. D.

(1) No. (2) It is very likely that this university will have a course of electrical engineering.

Transmission of Power.—I have at my disposal water power which I wish to utilize in transmitting power to a distance. What numbers of THE ELECTRICAL WORLD give accounts of such work? W. M.

We would refer you to THE ELECTRICAL WORLD of May 25, 1889.

Porous Separation in Accumulators.—Is it practicable to use a porous cell inclosing the negative material as a separation in a storage battery cell? F. F. R.

Where porous separation is made in storage cells a plate of porous material is used; but it is doubtful if much advantage is to be gained by the arrangement, as it adds much to the internal resistance, and a completely inclosing porous cell would increase this resistance of the cell still more than the separating plate.

Dynamo Action.—I have built an eight-light dynamo, but have failed to make it work as a shunt machine. It runs three lights as a series dynamo, but the lamps will not come up to candle power unless I flash them—that is, short circuit on the mains. Can you enlighten me as to the cause of my trouble? C. E. P.

It is impossible for us to know what is the trouble unless we have more detailed information as to the construction of the machine. "An eight-light dynamo" is rather insufficient data for us to deal with.

Induction Coil.—In an ordinary medical induction coil please explain the reason why the strength of the current or shock is increased by removing a tube of non magnetic material, such as brass, glass, etc., from the coil. I do not understand how the inductive or magnetic effect can be increased or diminished by the removal of such a non-magnetic tube. C. A. L.

The effect of the tube you mention is to fritter away part of the energy of the primary current by inducing electric currents in the tube itself, thus reducing the amount of work that can be done in the secondary coil, and partially shielding it. The tube must be of conducting material to produce any effect.

How to Polish Hard Rubber.—A correspondent writes the following letter in reference to the above: "In a recent number of THE ELECTRICAL WORLD 'Engineer' asked how to polish hard rubber. Let him use a felt lap charged with the finest grade of pumice stone mixed with enough lard oil to make a thick paste. Run the lap at a high speed, and, of course, apply the rubber to the *side*, not the rim of lap. He can get a beautiful finish on iron by bluing it. Polish the article with finest emery and bury in brass filings on an iron plate. Apply heat, and as the color comes on the iron uncover the edges and corners or they will turn light from too much heat. Lacquer or oil when cooled to about 200 degrees and the iron, if properly treated, will be a purplish black. If overheated so as to become a very light blue it can be repolished and blued again."

Cause of Heat in Resistance Coils.—Please answer the following questions through your paper: (1) Is the heating in resistance coils due to other causes than the passage of the electric current? (2) Would increasing the area of the magnetizable iron cores of resistance coils, without increasing the length of wire coil, lessen the heat caused? (3) If a motor were placed in the resistance coils would all, or a part only, of the heat be converted into motion? M. W. H.

(1) No. (2) No, for with the same current the loss due to the resistance of the wire would be practically constant. (3) A given current through a given wire will produce the same amount of heating whatever is in circuit with it. You can only reduce the amount of heating by reducing the cause—that is, the current. This supposes that there is no external source of heat, such as there would be in the core of an alternating electromagnet that of itself grows hot and tends to heat up the wire surrounding it.

Resistance of German Silver and Brass.—(1) What is the resistance of a German silver wire one foot long and one millimetre in diameter? (2) What is the resistance of a similar wire of brass? (3) When measuring high resistances should I use a high-resistance galvanometer? (4) What are the resistances (in a 400-light 110-volt Thomson-Houston dynamo) of the shunt-wound wire on field magnets, the series coils, the German silver shunt and the armature wire? W. M.

(1 and 2) As the composition of German silver and brass varies considerably it is impossible to give resistances unless you state the particular kind of alloy. In dealing with alloys it is best to measure a sample of the metal at hand. (3) In measuring high resistances a "long coil" galvanometer is used in connection with the bridge. (4) We have not the data at hand, but the company making the dynamo will perhaps furnish it.

Arc Light Carbons.—Will you please let me know what is gained by using a five-eighth inch carbon instead of a seven-sixteenth inch in the Thomson-Houston double carbon lamps? It has been claimed that the five-eighth inch carbon will last 14 hours, which is the longest time we burn; and, also, that by using the larger carbons, one trimmer can trim two routes, one one day, the other the next. Please say what difference it will make in candle power, and any other information bearing on the subject. SUBSCRIBER.

The life of a carbon varies directly with its diameter and inversely with its resistance, supposing the carbons to be of the same texture and to be operated at the same voltage. One actual test on carbons of the size you mention gave 10.6 hours for the seven-sixteenth inch carbon and 13.6 hours for the five-eighth inch carbon. The light given by the two will be practically the same, but the smaller carbon would probably burn rather more steadily. You would do well to correspond with the Thomson-Houston Company as regards their practical experience with five-eighth inch carbons on their regular current.

News of the Week.

THE TELEGRAPH.

Mr. Raikes, the British Postmaster-General, has prohibited district messenger systems in England, because the boys, by carrying letters, would infringe on the monopoly of the postal service. Telephones are practically banished from England because they interfere with the telegraph monopoly of the department. There would seem to be a wide difference between the American and the English idea of the proper province of a government. Opponents of American postal telegraphy find strong arguments against the innovation in the proscriptive course of the authorities at London. It is one thing for a government to furnish facilities required by all the people, but quite another to make a branch of the public service a monopoly so close as to obstruct private enterprise and invention designed to promote the general good. It is bad to be governed too much.

THE TELEPHONE.

Telephone Monopoly.—The telephone company operating in Baltimore, Md., has announced its purpose to increase the rental of its instruments, and at the same time to restrict their use. This action has stirred up considerable public indignation, and quite a large number of citizens have signed a paper pledging themselves to discontinue the service in the event of the threatened increase being made. The company proposes to increase the rental from $100 to $120 per year.

THE ELECTRIC LIGHT.

Aiken, S. C.—J. G. Gardner will establish an electric light plant.

Knoxville, Tenn.—New machinery is being added to the electric light plant of the Knoxville Electric Light and Power Company.

Navasota, Tex.—E. L. Bridges and others have been awarded a franchise by the city council to erect and operate an electric light plant.

Tallapoosa, Ga.—Additional machinery has recently been added to the electric light and power plant of the Vernon Light and Power Company.

The Alton Gas and Electric Light Company, of Alton, Ill., has petitioned the City Council for a franchise to erect a $25,000 electric light plant.

Abingdon, Va.—The Abingdon Water-Works Company intends substituting an alternating system for its present incandescent system of electric lights.

Greenwood, Miss.—An isolated incandescent electric light plant is shortly to be installed in the iron foundry and machine shops of the Ragsdale Manufacturing Company.

Mr. W. F. Reed, who owns most of the stock of the Montclair Electric Light Company, of Denver, Colo., is building a handsome new station and expending about $25,000 in improvements, including several miles of "K K" wire.

The Ogden City (Utah) Electric Light Company and the Citizens' Electric Light Company are reported to have practically consolidated, it having been agreed to pool and maintain the rates of the Citizens' Company.

The Moberly Gas and Electric Company, of Moberly, Mo., has been incorporated, with a capital stock of $30,000. The incorporators are L. M. Rumsey, James Green, George A. Madill and Francis A. Baumgardner.

Middlebury, Vt., now has in successful operation an electric light plant with all lights taken. Mr. S. L. Miller, the superintendent, who started the boom, against much local opposition, is now very busy keeping pace with the demand for the light.

Salem (Mass.) Street Lights.—The committee on lamps and lighting at Salem has under consideration the preparation of a new contract for street lights with the electric light company. The present three years' contract with the company is about to expire. Salem now pays 47 cents per light per night, burning from twilight to dawn every night in the year. The total expense is about $30,000.

Stole the Platinum Tips.—The illustrated description of the Narragansett Electric Light Company's station at Providence in THE ELECTRICAL WORLD of Feb. 21 will be remembered. The chimney stack of the station—one of the largest in New England—is about 250 feet high. Last Thursday night somebody climbed up inside the chimney, cut off and carried away the platinum tips with which the lightning rods are surmounted. It required great strength to bend the points so as to get at the precious tips. The

platinum was cut off with pliers. The value of the booty for which the thief risked his life does not exceed $50.

Middlesborough, Ky.—This town, only two years old and of 7,000 inhabitants, has had in successful operation for 16 months a Thomson-Houston plant of 51 arc lights and 1,300 incandescent lights. This plant, however, has proven too small for the requirements of the town, and a new brick station building is being erected, where is to be installed an extra capacity for 60 more arc lights and 1,300 more incandescent lights. The new plant will be in operation in a few months.

Annapolis (Md.) Electric Light Contract.—The city council received the offer of the Annapolis Consolidated Electric Light and Gas Company last week to light the city at the expiration of its contract, on July 1, 1891. The sum paid now is $3,500. The proposal made doubles the present amount for electric lighting. Mr. W. Hallam Claude, representing the Edison Electric Light Company, and Mr. C. W. Robinson, of the Pennsylvania Globe Gaslight Company, appeared before the board in reference to lighting the city. The board appointed a committee of three to prepare proposals and to receive bids to light the city on Monday, March 30, in open meeting.

The Northwest Thomson-Houston Electric Company has recently completed what has been pronounced the most complete theatre installation on the Pacific coast. The electrical equipment consists of one Thomson-Houston motor type incandescent generator of 500 lights capacity, which furnishes current for 450 lights in the theatre proper and 200 lights in stores and offices. All border and foot lights are arranged in two circuits, so that each alternate light may be put in circuit. Half of any border of foot lights may be used. There are 16 circuits, all regulated from the stage switchboard. The installation was made under the direction of Mr. W. L. Wright. The Portland branch of the Northwest Thomson-Houston Electric Company has recently closed contracts for electric light plants for the towns of Rosburgh, Ore., and South Bend, Wash.

THE ELECTRIC RAILWAY.

Bristol, Tenn.—The Equitable Construction Company contemplates the construction of an electrical railroad.

Atlanta, Ga.—The Capital Railway Company is inviting bids for the construction of five miles of electrical street railway.

Mr. H. L. Pierce, of Leominster, Mass., and a large number of others from the same place and neighboring towns, are pushing through to an issue the Leominster Street Railroad Company. The road is to be about four miles in length.

Johnstown, Pa.—The tracks of the new electric street railway are being laid. Mr. A. E. Baker, the energetic superintendent of the traction company, is pushing the road to completion. The speed with which this town has recovered from the famous flood is marvelous, and the new town will go back to no old methods, if it is in the power of the enterprising element at work.

The Wilmington Street Railway Company, of Wilmington, N. C., has been purchased by Mr. E. S. Hawks and Capt. J. H. Barnard. The road is four miles in length and uses horse cars, but the mileage will be increased to nine miles, and electric motive power will be used. As yet it is undecided which system will be used. Mr. Hawks is vice-president of the Winston-Salem Railway and Electric Company, and is at present at Winston, N. C.

The Baxter Slow-Speed Motor.—In our descriptive articles of the Westinghouse and Thomson-Houston slow-speed car motors we gave precedence to the Thomson-Houston motor as being the first motor of the kind in the field. But the successful trial of the Baxter motor at Baltimore, Md., on Dec. 26, 1890, really antedates the introduction of all other slow-speed car motors. However, the first motor to be placed in actual service in the field has been the Thomson-Houston motor.

A Good Car Record.—Four cars of the Denver Tramway Company, equipped with Thomson-Houston motors, made a very remarkable record of mileage during the second week in February. The tabulated statement of each day's mileage, as furnished to us by Mr. O. T. Crosby is given in the following table. The total length of the run is 13.4 miles per round trip and the schedule time for the round trip 90 minutes.

	Car 300. Miles.	Car 301. Miles.	Car 302. Miles.	Car 303. Miles.
Feb. 7	201	201	187	201
" 8	201	187	187	201
" 9	201	187	147	187
" 10	187	187	174	187
" 11	201	187	187	214
" 12	201	201	174	187
" 13	201	187	174	187
Total for the week	1,393	1,337	1,230	1,364
Daily average	199	191	176	195

LEGAL NOTE.

Ultra Vires Acts of Corporation Officers.—A corporation manufacturing and dealing in metal goods, intrusted the management of its business with its treasurer, who on its behalf, but without previous action of its board of directors, contracted with another company, engaged in manufacturing carbons for electric lighting, to sell all carbons manufactured by the latter company during five years. After such business had been carried on openly for more than a year without objection by any one interested in the metal corporation, its treasurer, to procure means to enable the carbon company to supply the increased demand for carbons, indorsed in the name of his own company a promissory note made by the carbon company, procured it to be discounted, and paid the proceeds to the latter company. The metal company was compelled to pay the note. It could not recover damages therefor from its treasurer, although the business in which the note was given was *ultra vires*, the directors and stockholders had so far acquiesced in it that it had become the business of the corporation.

(Holmes, Booth & Haydens v. Willard, Court of Appeals of New York, 25 N. E. Rep., 1,083.)

PERSONALS.

Mr. Thomas J. McTighe, of Messrs. Barry & Co., electrical engineers, New York City, is in Omaha, Neb., where he will superintend the installation of the Lincoln street railway plant.

Mr. Wm. J. McElroy, the well-known inventor of the auto-condenser system of electric lighting, of Pittsburgh, Pa., has recently severed his connection with the Standard Underground Cable Company, and is open for an engagement.

Sir Wm. Dawson, LL. D., F. R. S., principal and vice-chancellor of the McGill University, Montreal, has written to Mr. J. A. Corriveau tendering the freedom of the museum and library of the university to the members of the National Electric Light Association while in the city.

Industrial and Trade Notes.

Mr. A. L. Daniels, of North East, Pa., was in New York this week, and reports increasing sales of the Eureka Tempered Copper Company's specialties.

Mr. George L. Kirkbam, manager of the Northwestern Electric Specialty Company of Chicago, reports a rapidly increasing demand among physicians for the Simpson storage battery.

"Tobin Bronze" is the title of a pamphlet issued by the Ansonia Brass and Copper Company, of New York. The book contains tests of good qualities of this metal and many testimonials of its merits.

Holmes, Booth & Haydens' well known representative, Mr. La Fayette Cole, is making their "K. K." wires better known in the far West than the notorious three K's were ever known in the sunny South.

Mr. Chas. M. Rumrill, of 109 Liberty street, New York City, will not act as exclusive New York agent for Messrs. Gould and Watson, as recently announced, but will carry a full line of their specialties in stock.

The Crosby Electric Company, always in the front with novelties, is now sending out a special postal card printed in blue inks, which calls attention to the celebrated Crosby dry battery cell and the improved Hussey bluestone cell.

The Eastern Electric Supply and Construction Company, of 65 Oliver street, Boston, Mass., have issued for 1891 its catalogue and "Price List A." A most complete line of electrical goods is kept in stock by this enterprising company.

The Insulite Socket is still having a large sale, and some very commendatory letters have been received from dealers and central station superintendents. Of over 35,000 used by one large company no complaint has been received of a single socket.

The Walter Hay Manufacturing Company, of Chicago, Ill., sold since Jan. 15, 1891, 3,000 of its electric bells, and as it is a new bell it speaks extremely well of its good points. Of this number, 24,832 bells were sold in the month of February, or in 28 days.

Messrs. Joseph C. Paulus & Co., of Philadelphia, agents for the Charles Munson Belting Company, have a novel way of convincing the public of the superiority of their belting by offering one dollar for every inch of stretch taken out if allowed to put the belt on.

Messrs. W. H. Weston & Co., manufacturing electricians, who have recently moved to the new factory at 830 Filbert street, are making a specialty of knife-edge switches, and have fitted up with machinery for the purpose of manufacturing the same on a large scale.

Messrs. Jas. J. Murray & Co., of Philadelphia, who are recognized as the largest manufacturers of globes and shades in this country, are scarcely able to fill their orders while running at their full capacity. Additional buildings are being erected which will considerably increase their already large plant.

The Gibson Gas Fixture Works, of Philadelphia, are sending out cards to all patrons containing the following: "We will indemnify purchasers of our electric or combination fixtures against all infringement suits. The 'trust' threat is simply another desperate attempt to intimidate dealers."

The Magnetic Separator Company, of Watervliet, N. Y., in which Troy and Albany parties are interested, has just closed a contract with the Hartzell mines of Rittenhouse Gap, N. J., placing an order for a machine of 150 tons capacity per day, the ore to be separated by the Ball and Norton process, using the latest improved Monarch magnetic separator.

Insulator Pins.—The pins made of wrought iron by John M. Klein & Co., of San Francisco, for electric light and railway line work have a lead screw cast upon the iron body. The screw, being lead, prevents the breaking of insulators from expansion or contraction. The stem of the pin, being wrought iron, will not decay and break, allowing the wire attached to fall in the street.

The Electric Merchandise Company, of Chicago, has been appointed the selling agent for the Tramway Rail Company, of Pittsburgh, Pa., manufacturers of steel rails of all descriptions, chairs, tie plates, splice bars, frogs, switches, crossings and other street railway equipment. It is the intention of the company to follow well-established principles, making all equipment strong and durable.

The Electrical Supply Company, of Chicago, Ill., is making a specialty of complete fire-alarm service and district messenger outfits. In the warerooms at 171 Randolph street a large sample board is fitted up, showing the various instruments used and the methods of operation. The cost of equipping a town with a complete fire-alarm service is much less than most people imagine, and in this age a town without this safeguard is not complete.

Messrs. Stanley & Hall is the firm name of a company recently incorporated with a capital stock of $30,000. Mr. A. F. Stanley is president, Mr. H. Hall is secretary and treasurer, and Mr. S. H. Bassett, formerly of the Birmingham (Conn.) Iron Company, is vice-president. This company already occupies an enviable position in the electrical supply field, and the many novelties now being brought out will no doubt increase their trade very largely the coming year.

Messrs. Greene, Tweed & Co. call the attention of the electrical trade to their new "Manhattan" packing for piston rods and valve stems. This packing is made from the best yarn, placed on a machine and wound on spools, after which it is put on a saturating machine, and each strand goes from the spool through the saturating process, so that each fibre is thoroughly soaked with best floated plumbago and oil, free from acid, one of the best packing materials in the market.

The Electric Mutual Insurance Company, of 85 Water street, Boston, has received a letter from the Central Electric Company, of Portage La Prairie, Manitoba, dated March 2, 1890, acknowledging the receipt of a check in full payment of loss by fire on January 25 last, proof of which was not submitted until February 10. The letter further indorses the management of the Mutual, and says it deserves the best consideration from every electric company in the United States and Canada.

Messrs. Wm. Baragwanath & Sons, of Chicago, Ill., the manufacturers of the well-known Baragwanath feed water heater, have found it necessary to add to their equipment a number of extra heavy punching and shearing machines, in order to accommodate their rapidly increasing business. The general tendency in this line is to larger and heavier heaters, which are rendered necessary by the enormous power stations which have been erected lately. This firm has recently turned out over 50 heaters ranging from 800 to 2,200 h. p.

A New Supply House.—Mr. R. M. Jones, of Salt Lake City, Utah, well known to the electrical fraternity in the past, is opening an electrical supply house in Salt Lake City that will no doubt prove of great convenience to the lighting and railway stations on the Pacific slope, as well as to contractors, who have often felt the need of a well-stocked supply house close at hand. Mr. Jones apparently appreciates the importance of carrying a good stock, as he has ordered a carload of "K. K." wires and an abundance of other standard supplies. His well-known activity and enterprise insure the success of the business.

Crocker-Wheeler Factory Extension.—The establishment of the Crocker-Wheeler Electric Motor Company, West Fourteenth, West Thirteenth and Washington streets, New York City, is soon to be enlarged to double its present size. There will then be a large show room where all sizes of the Crocker-Wheeler motors will be exhibited in operation, with their various applications. There will also be a dust-proof department for the storage of finished motors and motor frames ready for being wound. The company finds it necessary to carry a large number of motors in stock unwound for filling special orders. Business is very good with the company.

The Economic Electric Company.—The wonderful growth of the electrical industry is well illustrated by the large business now being done by the Economic Electric Company, of Boston, with factories at Brockton, Mass. This company is yet young, its first lamp having been placed on the market in the fall of 1890. The "Economic" lamp is the result of several years of experimenting in order to make a lamp that would be absolutely the best. At no time since the first lamp was sold has the company been able to fill orders, and the capacity of the factory, which has been 1,000 lamps a day, will soon be 4,000 lamps daily. These lamps are now in use throughout the United States, and interested parties visiting New York can see their practical work in the *Herald* and *World* buildings.

The Packard Lamp.—In producing this lamp the aim of the manufacturers—the New York & Ohio Company, of Warren, O.—has been to make this the best lamp possible, regardless of cost, and this lamp is presented not as a new or experimental one but as the result of seven years' experience in the commercial manufacture of lamps on a large scale. In all the company's high-volt lamps, 90 volts and upward, the carbon is supported at the tip by means of an inwardly projecting glass stem carrying a platinum hook. This prevents any drooping or vibration of the carbon, removing all danger of breakage from these causes, and adding greatly to the symmetrical appearance of the lamp. The low-volt lamps, having a shorter carbon, do not need this support and it is omitted. Aside from the intrinsic value of the process of manufacture, the workmanship and materials are of the very best, no molded glass or second-hand shells being used. Although in business but a short time, the company has an excellently equipped factory, with a large force of experienced hands, and reports business very good. Its lamps are said to be giving great satisfaction.

The Hine Eliminator Company, of 106 Liberty street, New York City, has received a letter from the Queen City Electric Company, of Cincinnati, saying that it is using one of the 4½-inch Hine eliminators in the drive pipe of a 100 h. p. Ball engine, running two 600-light dynamos at 350 revolutions; one 5 inch eliminator on a 16 × 16 150 h. p. Ball engine, running at 240; also a 5½-inch eliminator on a 150 h. p. Corliss 30 × 20 engine, running at 90 revolutions. They are all verticals and are doing first-rate work. Before putting in these eliminators, when the boilers were being worked pretty hard, the high-speed engines especially would at times knock their cylinder heads out, due to the wet steam, and sometimes the boilers would get to foaming, and it was only at risk of wrecking the engines that the company could run them. Since the introduction of the Hine eliminator the company has not had this trouble, although it has frequently loaded these engines beyond their capacity, driving them with 100 pounds of steam. The company states that it is getting as good results as from another device that cost double the money.

The Toronto Construction and Electrical Supply Company, Limited, of 63 69 Front street, West, Toronto, Canada, with a capital stock of $250,000, will be the largest electrical supply house in the Dominion. This company will also do general electrical engineering and contracting. The board of directors has been well chosen. The names are: W. R. Brock, president, director Toronto General Trusts Company, director British Canadian Loan and Investment Company; H. P. Dwight, first vice-president, vice-president and general manager Great Northwestern Telegraph Company, director Toronto Incandescent Electric Light Company; Frederic Nicholls, second vice-president and general manager, director Toronto Incandescent Electric Light Company, director Manufacturers' Life Insurance Company; W. D. Matthews, director Canadian Pacific Railway, president Dominion Safe Deposit Company; Robert Jaffray, president Toronto Real Estate Investment Company, vice-president The Land Security Company; Hugh Ryan, director Imperial Bank of Canada, director Trusts Corporation of Ontario; J. K. Kerr, Q. C., director North American Life Insurance Company, director British Canadian Loan and Investment Company; E. B. Osler, director Dominion Bank of Canada, manager North of Scotland Canadian Mortgage Company. The catalogue of the Toronto company is now being prepared.

An Electric Hoisting and Conveying Machine, the invention of Ezra Nicholson, of Cleveland, O., has been in operation during the past few weeks in that city, and has been examined by prominent iron ore and coal men and pronounced a success. The designing and construction of the plant have been in charge of W. P. Williams, a member of the American Society of Civil Engineers. Mr. Williams and Mr. Nicholson have patented several different systems for the hoisting and conveyance of bodies by electromotive power, and will shortly organize a company to commence the manufacture of plants for coaling terminals and general work. This machine is especially adapted for economic use in loading and unloading vessels or cars of iron ore, coal or general merchandise and conveying the load to any desired point. A 30 h. p. Rae electric motor is mounted upon a light tram car holding suitable hoisting mechanism, and the operator riding on this car hoists the load from any desired point and rapidly conveys it to the place of unloading. The constant presence of the operator over his work has a great advantage over steam automatic cable systems in present use. The present work performed by the plant is unloading a vessel of iron ore, hoisting a load of 3,000 pounds vertically 5 feet per second, then traveling across a bridge 20 feet high and 200 feet long spanning the ore dock, the cross travel being made in 10 seconds, and the operator stopping the car, holding the bucket, and dumping the load at any desired point. Systems have been designed for quarry, rolling mill and contractors' use by Messrs. Nicholson and Williams.

Business Notice.

A 3-H. P. Mather Electric Motor was put in some months ago to run the presses in the office of the *Evening Leader*, at Carbondale, Pa. The proprietors used it with great satisfaction for three months, when the supply of current was taken from them by reason of the failure and stoppage of the electric railway. The result is they now have a fine new machine on their hands with no use for it. Some one could buy it for about half its cost, by corresponding with E. D. Lathrop, the business manager of the pap

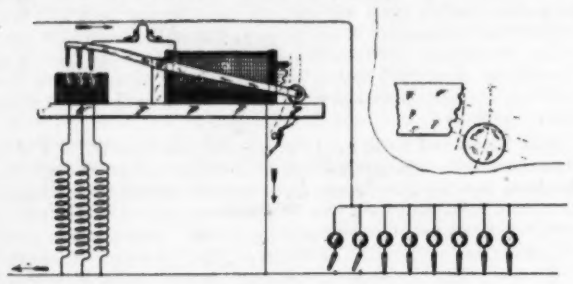
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED MARCH 17, 1891.

448,199. Electric Motor Truck; Francis O. Blackwell, of New York, Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed June 17, 1889. The combination, with an electric motor, having a framing journaled upon the axle of a vehicle and carrying gears connecting the armature shaft with the axle of a framing independent of the car body attached to the journal boxes of the truck outside of the wheels, supporting the free end of the motor and provided with a cushion modifying its action upon the journal boxes.

448,246. Support for Electric Wires; Chas. A. Lieb, of New York. Application filed Nov. 19, 1890. A supporter for electric wires, comprising a metallic body part and a metallic nut placed within the body part and between insulating material, and a threaded ring engaging with threads on the body part for confining the insulating material in place.

448,260. Motor-Suspension for Railway Work; Edwin Wilbur Rice, Jr., of Lynn, Mass. Application filed Aug. 15, 1889. This invention consists in the provision of a frame sleeved to the car axle and provided with journal-bearings for the armature



No. 448,279.—ELECTRIC LIGHTING SYSTEM.

axis and the axes of any intermediate gear between the armature and car axle, the motor field-magnet being supported on the armature axis.

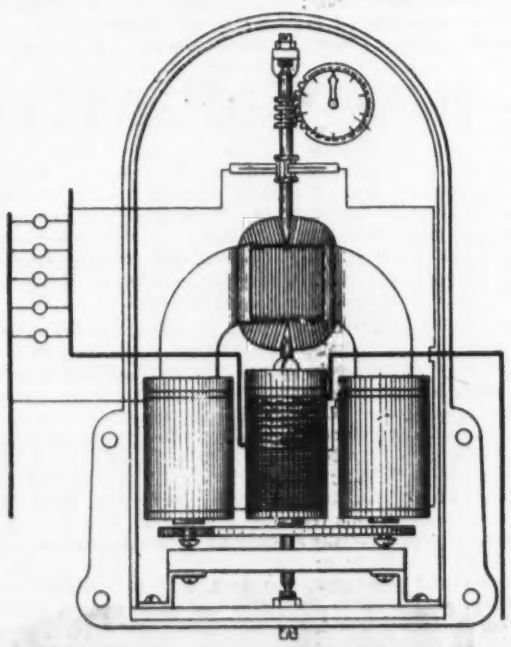
448,273. Electrical-Controlled Valve; John V. Stout, of Easton, Pa. Application filed Jan. 31, 1890. The combination, in a regulating system, of a circuit and a normally open circuit controller, a battery and magnets in series in the circuit, one of the said magnets operating the circuit controller and another of said magnets controlling the motor for the regulating valve, and a short circuit for the battery.

448,274. Electric Temperature Regulator; John V. Stout, of Easton, Pa. Application filed Jan. 31, 1890. The combination, in a regulator, of a thermostatic bar having conducting terminals, a revoluble plate having co-operating contacts, and means for turning said plate, whereby one of the co-operating contacts rubs across one of said terminals, and is carried out of the path of movement of the bar, and another contact is brought into the path of the bar on its return movement.

448,279. Electric Lighting System; Elihu Thomson, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed May 21, 1886. The invention consists in the combination of an electromagnet constructed to move its armature step by step in response to definite changes in the strength of said magnet, and connected to the circuit so as to be in derived connection around the lights or other translating devices, with means whereby the successive movements of the armature introduce resistances of definite amount and equal to the number of lights that may be extinguished by accident or otherwise in the group supplied. (See illustration.)

448,280. Electric Meter; Elihu Thomson, of Swampscott, Mass. Application filed Nov. 20, 1890. In an electric meter, the combination of an electric motor of constant torque operating the register with a damping mechanism consisting of a closed circuit conductor rotating in a magnetic field whose strength is determined by the differentiation between a definite magnetic force produced in part at least by the motor itself and that due to the current flowing in the main work circuit. (See illustration.)

448,291. Circuit Closer for Clock; Henry A. Chase, of Boston, Mass. Application filed Sept. 6, 1889. This invention consists in a circuit-controlling device for time mechanisms, consist



No. 448,280.—ELECTRIC METER.

ing of two independent members, the combination, with one member, of the second member provided with a lug, a motor mechanism to move said second member, a locking device for said member, provided with two detents out of line with each other, and an independent motor mechanism to operate said locking device to disengage one detent from the lug and engage the second detent with the lug and thereafter to disengage the second detent from the lug.

448,303. Driving Mechanism For Dynamo-Electric Generators; Sidney H. Short, of Cleveland, Ohio, Assignor to the Short Electric Railway Company, of same place. Application filed Nov. 6, 1890. A dynamo-electric generator mounted on an insulating base and having the steam-engine directly coupled thereto and provided with the driving shaft in two parts rigidly connected together, one supported on the steam-engine and the other having the armature fastened thereto, with an insulating section between said parts.

448,315. Tail Light for Railway Trains; Arthur W. Berne, of New Orleans, La., Assignor of five-eighths to Brownlee W. Taylor, Charles A. Fish and Richard J. Lowden, all of the same place. Application filed March 14, 1890. An apparatus for indicating the movement of a railway train at night consisting of a metal arm adjusted on the axle of a car, said arm being rotated by the revolution of the axle of the car, terminals of an electric circuit closed by said arm, electromagnetic devices operated by the circuit, and a screen operated thereby for flashing a light.

448,317. Electric Sad Iron; Charles E. Carpenter, of Minneapolis, Minn., Assignor to the Carpenter-Nevens Electro Heating Company of same place. Application filed June 21, 1890. In an electric sad iron, the combination with the heated surface plate and a compressing plate secured thereto, of an electrical resistance or conductor interposed between said plates and an insulation interposed between said resistance and each of said plates.

448,322. Call System; Louis Digeon, of Paris, France. Application filed Nov. 1, 1887. A call system comprising a normally closed telephone circuit, a plurality of main and call stations in said circuit; a normally interrupted local alarm circuit at each of said main stations, a switch in the local and telephone circuits at said main stations adapted to automatically close the local alarm circuit by dropping out of the magnetic influence of the telephone circuit when the latter is interrupted, and a gravity switch lever at each call station arranged to vibrate between contacts in the telephone circuit, and operating when released to momentarily interrupt said circuit and again close the same.

448,326. Method of and Apparatus for Developing Mechanical Motion from Electrical Energy; Rudolf Eickemeyer, of Yonkers, N. Y. Application filed July 20, 1888. The method of developing mechanical motion from electrical energy, which consists in intermittently varying the polar conditions of an electromagnetic field, and in like manner varying induced polar conditions in a movable element by correspondingly varying separate supplies of field exciting energy derived from any suitable source of electricity.

448,328. Electric Railway; Justus B. Entz, of New York, Assignor to the Waddell-Entz Electric Company, of same place. Application filed July 3, 1890. This invention consists in the employment of a continuous armature, which armature is stationary, and which extends from end to end of the track to be traversed by the vehicle to be propelled, with the aid of brushes or analogous contact devices that also travel at the same rate as the vehicle, and that convey the current from the mains or conductors which are laid along the route to that portion of the armature which is under the influence of the field magnet. (See illustration.)

448,329. Telephone; Stephen Dudley Field, of Stockbridge, Mass. Application filed May 25, 1889. A telephone having its diaphragm supported between polar extensions of the two limbs of a magnet and magnetically connected at or near the rim, with an iron bridge connecting the poles of the magnet, each of the polar extensions being provided with a line coil wound to develop like polarities at the confronting ends. (See illustration.)

448,331. Commutator Brush; Karl G. Frietch, of Schnectady, Assignor to the Edison Machine Works, of New York, N. Y. Application filed June 28, 1890. The combination, in a commutator brush, of a contact brush pressed against the commutator cylinder and a brush to which the line is connected bearing against said contact brush adjacent to its contact end.

448,338. Segmental Resistance-Board; Gideon David Hand and Osborn Parker Sells, of Chicago, Ill. Application filed Aug. 11, 1890. The invention consists of segmental plates arranged in a circle and having a double plate located in alignment therewith, another plate surrounded by and concentric with said plates, having a pivotal stud projecting outward from its centre and connected to the positive pole of the generator, a pinion journaled on said stud, and a brush secured to and moving with said

No. 448,329.—TELEPHONE.

pinion, in combination with a segmental gear, and a handle projecting in the opposite direction from the boss thereof.

448,351. Electric Arc Lamp; Karl Kurmayer, of Vienna, Austria-Hungary. Application filed Sept. 15, 1890. In an arc lamp, the combination of converging and longitudinally-slotted carbon-holders, a movable bearing in each of said holders, to which bearing the pencil is secured, and a coupling-rod extending loosely through the said bearings.

448,359. Support for Electric Cables; Henry Bert Nichols, of Boston, Mass. Application filed Nov. 15, 1890. A cable clamping or supporting device comprising a rigid plate or holder, clips or clamps engaged at their inner ends with said plate, said clips constituting a sectional socket formed to receive the cable, and means for compressing said socket upon the cable.

448,365. Electric Switch; Ransom D. Pratt, of Marlborough, Mass., Assignor of two-thirds to Julian P. Wood and Herbert J. Willard, of same place. Application filed July 7, 1890. An electric switch having contacts, a pivoted bar to engage said contacts, provided with a V-shaped projection extending toward the push-button, a push-button for operating the bar, and a spring for retaining the push-button out of connection with the bar, the button being provided with a rod to engage the bar, alternately at each side of the projection to open or close the circuit.

448,378. Electrical Street and Station Indicator; Francis H. Soden, of Chicago, Ill. Application filed March 20, 1890. The combination with an indicator controlling device, of a battery and a dynamo, an automatic switch controlled by the current from the dynamo and arranged for placing the battery and the dynamo alternately in circuit for operating the indicator controlling device, and a trolley adapted for opening and closing a circuit, wherein said battery and dynamo may be alternately placed by the automatic switch.

448,395. Insulator; Geo. K. Wheeler, of Chicago, Ill. Application filed Nov. 21, 1890. This invention is a cone insulator consisting of two non-conducting portions, one of which is cone-shaped to receive a hood, which are connected by male and female threads and each carrying a metal hanger.

448,398. Signal Box; John C. Wilson, of Boston, Mass., Assignor to the Municipal Signal Company, of Portland, Me. Application filed May 17, 1887. A multiple signal transmitter, comprising an endless band and a series of groups of signaling surfaces, each group ranged transversely thereon and a contact pen adapted to co-operate with any one group of signaling surfaces.

448,399. Signal Box; John C. Wilson, of Boston, Mass., Assignor to the Municipal Signal Company, of Portland, Me. Application filed May 17, 1887. In a signal box the contact pen and motor mechanism for rotating it and the signal drum and means for rotating it, combined with an engaging latch for the drum, and means for effecting the movement of the latch to release the drum.

448,400. Signal Box; John C. Wilson, of Boston, Mass., Assignor to the Municipal Signal Company, of Portland, Me. Application filed May 17, 1887. In a signal box a rotatable contact pen, combined with a series of signaling surfaces arranged on a frame or carrier which is movable in a direction parallel with the axis rotation of the contact pen to present one or another signaling surface to the contact pen, a pointer connected to said frame or carrier for moving it, and a dial.

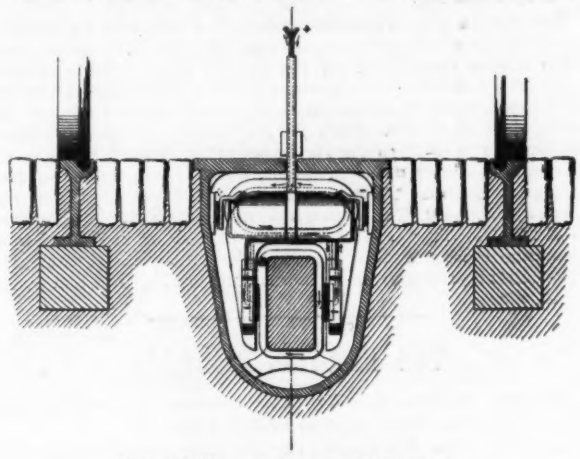
448,401. Apparatus for Ventilating Railroad Cars; Robt. J. Wilson, of Pittsburgh, Pa. Application filed Nov. 25, 1889. This invention consists in the combination, with the ventilating devices of a car, of an electrically operated device whereby the ventilators are opened and closed by means of the action of compressed air or other suitable fluid.

448,418. Electric Arc Lamp; James W. Easton, of New York, Assignor to P. Minturn Smith, of Plainfield, N. J., and Wm. D. Perry, of Brooklyn, N. Y. Application filed March 20, 1890. In an electric arc lamp, the combination of a brake wheel controlling the movement of the carbon rod, and a spiral spring bearing against the periphery of said wheel, one end of said spring being secured to a fixed portion of the lamp or frame and the other end being connected with the core or armature of a solenoid or magnet, whereby the tension of said spring is varied with changes in the resistance of the lamp circuit.

448,431. Electric Switch; Edward H. Johnson, of New York. Application filed March 27, 1885. A hand-switch for making and breaking an electric circuit having a moving contact piece, a spring connected with said moving contact piece by a loose connection, and a free handle connected with such spring, and acting by its movements to strain the spring and release it without making or breaking the circuit, whereby the spring will then throw the moving contact piece by direct spring action to the end of its movements, and the circuit will be made or broken by a spring-snap action.

448,461. Underground Conduit for Electric Railways; Robt. A Stewart, of Allegheny, Pa. Application filed Oct. 4, 1890. An underground conduit for electric and like railways, having a chamber extending parallel with the rail and having a slot extending sidewise into the chamber for the passage of the trolley-arm or like device. (See illustration.)

448,468. Electric Wire Support and Cut-Out; Edwin R. Whitney, of Manchester, N. H., Assignor to the Electrical Supply Manufacturing Company, of same place. Application filed Nov. 4,



No. 448,328.—ELECTRIC RAILWAY.

1890. The combination of a base piece having a surrounding flange provided with main wire seats, combined with a removable cap adapted to enter within the said flange and to be secured to the said base piece, said cap having yielding clamps for engaging the wires in the seats on the base piece.

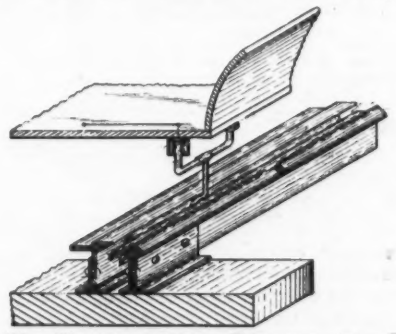
448,505. Trolley Support for Electric Cars; Benj. F. Crow, of St. Louis, Mo., Assignor to the Brownell & Wight Car Company, of Missouri. Application filed July 12, 1890. In a trolley support, in combination with a car body, a truss composed of a compression member and a tension member engaging the ends of the compression member.

448,523. Electric Railway; Rudolph M. Hunter, of Philadelphia, Pa., Assignor by mesne assignments to the Thomson-Houston Electric Company, of Boston, Mass. Application filed March 18, 1886. In an electric railway, the line conductors arranged in long sections, an electric generator for each section, and controlling devices, actuated by the strength of current in one section for controlling the supply of electricity to the next section, whereby the electric supply to all sections may be substantially or relatively the same, to the end that the same motor may run upon all sections.

448,561. Electric Railway Motor; Chas. J. Van Depoele, of Lynn, Mass. Application filed Oct. 22, 1889. The combination with a moving vehicle or vehicles, of one or more motors applied to propel the same, and means actuated by the movement of said vehicles for continuously distributing supply-current of continuous direction to the said motor or motors in accordance with the speed at which the vehicles are moving.

448,562. Electric Locomotive; Chas. J. Van Depoele, of Lynn, Mass. Application filed May 26, 1890. An electric locomotive comprising the two independent axles of a car truck, a single motor disposed between and separately spring-supported upon said axles, and provided with a suitable pinion upon its armature shaft, and dynamometric gears on each axle, said gears being all in direct engagement with the armature pinion.

448,563. Electric Railway System; Chas. J. Van Depoele, of Lynn, Mass. Application filed Dec. 13, 1890. A train system comprising a continuous-current supply circuit along the line of way, a vehicle or vehicles, a motor or motors, arranged to propel said vehicles and comprising a field magnet and an armature having a sectional winding and commutators therefor, and short-circuiting brushes thereon, adjustable with relation to the inducing poles of the field magnet to control the power and direction of rotation of the armature, a distributor receiving the con-



No. 448,461.—UNDERGROUND CONDUIT FOR ELECTRIC RAILWAYS.

tinuous supply current and converting the same into currents of alternating polarity, and connections between the distributor and the field magnets of the motors.

448,603. Electromagnetic Motor; Edwin D. Chapin, of Holliston, Assignor to Eugene Humphrey, trustee, of Boston, Mass. Application filed Aug. 21, 1889. In electric motor mechanism, a central operative shaft having a motor having its armature constructed and arranged to revolve around the central shaft, a non-revolving gear, and a system of speed-varying gear arranged to revolve in connection with and in part around said gear, and through which gearing the actuating armature imparts rotary motion to the central shaft.

448,604. Electric Cable; Wm. A. Conner, of Pittsburgh, Pa., Assignor to the Standard Underground Cable Co., of same place. Application filed Nov. 8, 1890. An electric cable consisting of a number of conductors, each covered with a fibrous insulating material, the conductors being grouped together to form a core, the core being provided with water-proof covering and a sheathing of material capable of withstanding a comparatively high degree of heat, and an exterior protective coating of lead.

448,618. Electric Railway; Rudolph M. Hunter, of Philadelphia, Pa., Assignor to the Electric Car Company, of same place. Application filed Sept. 24, 1886. In an electric railway, the combination of a looped track forming a return-circuit, and connecting with one pole of the generator, a looped conductor extending along the railway electrically independent of the rails of the track, and having its opposite ends connected with the other pole of the generator, an electrically propelled vehicle, having a motor mechanically connected to rotate the axle, a current-collecting device supported by the vehicle and making a traveling connection with the conductor, and a motor-circuit carried upon the vehicle, including the motor and connecting the collector device with the rails.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.